AUGUST 1933

VOLUME FORTY NUMBER EIGHT

CHEMICAL & METALLURGICAL ENGINEERING

ONE VOICE FOR ALL

• Chemical industry swings into line for immediate action by reviving its wartime Chemical Alliance, concentrating on the single objective of doing its part. So far the organization has been moving along horizontal lines, bringing together all of the divergent branches of a diversified industry. Next must come the vertical moves—the consolidations within the individual groups in order to agree on statistics and improved trade practices, thus to capitalize fully on the investment in the recovery program. Every chemical company in the country now has a dual duty: First, to join and support the Chemical Alliance so that it may speak with one voice for the whole industry. Second, to help bring its own branch of the industry back to the highest standards of practice and profit. Here is a true test of management!

WHO'S MISSING?

• In accordance with the plan announced in the May *Chem. & Met.*, helpful suggestions continue to come to the Committee on Award for Chemical Engineering Achievements. Unfortunately, some of the most interesting of these developments can not yet be described in our pages. But in order that the award be truly representative, the committee can not afford to overlook any important chemical engineering activities of any company in the process industries during the depression period. If you have some ideas or wish to make some inquiries about the Award, why not write to us? Address, Sec'y., Committee on Award, care of *Chem. & Met.*

NEXT MONTH

• The real facts and figures for chemical industry—a timely statistical study. The anode process of rubber deposition—a chemical engineering achievement. Coal washing process has interesting chemical engineering significance. Modern practice and equipment for handling chemicals. Plastic products and producers—bringing up to date the August '31 and September '32 compilations of A. F. Randolph. New flowsheet of electrolytic caustic soda manufacture. Materials of construction.

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NRA MEMBER U.S. WE DO OUR PART

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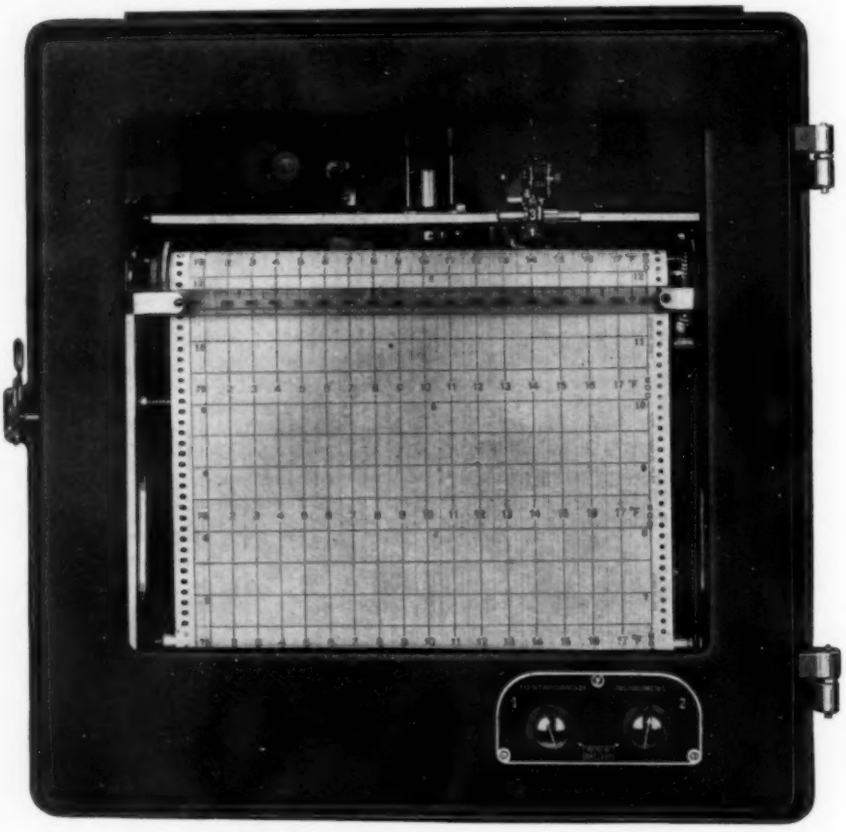

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PROCESS COMPETITION UNDER THE CODES

CAREFULLY BALANCED competitive relations that exist between many pairs of products and processes in chemical industry may shortly receive a rude upsetting as a result of NRA code activity. Increases in labor costs, at least in the beginning, will not rest evenly on all commodities. Competition will, therefore, be intensified and there may well be some significant changes in the relative standing of competitive processes. Some of these inequalities are worthy of immediate attention, even though in the end they may find a natural adjustment as the general increases in labor charges are reflected in fuel, power, raw materials and other elements in production costs.

Consider the case of caustic soda. In the electrolytic process, direct labor plus that required in repair and maintenance has been estimated to cost almost four times as much as in the competing lime-soda process. Now, suppose all alkali manufacturers sign the same code and there is a revision of wage rates with, say, a flat increase of twenty per cent. The electrolytic manufacturer, in proportion to his greater use of labor, must carry a considerably heavier burden than his lime-soda competitor.

In the manufacture of sulphuric acid, labor is probably twice as important for chamber plants as for contact plants. Reliable estimates calculated for the same raw materials and on a common basis of 100 per cent H_2SO_4 show that full compliance with the President's blanket agreement would raise the cost of labor for contact acid only 40 cents per ton, whereas the increase in chamber plants would be two or three times this much. This result comes not only because of the greater number of man-hours per ton in the latter type of plant, but also because the number of hours worked per week per man in chamber plants has customarily been much greater. These changes could also have important regional significance, resulting in shifting the competitive price zone from one manufacturing center toward another. For example, in the Middle Atlantic States sulphuric acid is commonly made by both chamber and contact processes. In Southern factories, the chamber process invariably is used. Territory hitherto dominated by the Southerner may be restricted and Northern contact acid may enter a larger area on an equal price basis.

Other interesting speculations follow along the same lines. Methanol, acetone and acetic acid as produced by synthesis have generally had an advantage as compared with these products when made by wood distillation. That advantage will probably be enhanced because the very nature of synthetic processes involves less dependence upon labor and more on capital investment in continuous equipment.

Throughout chemical industry there has been a steady advance in plant efficiency. Fortunately those companies that have achieved the highest productivity per man-hour are likely to be most favored by these NRA developments. This is only fair, for if the Administration should place a penalty on progressive management and technology, it could never command the respect and support of the public.

Let us not forget that it is this public that in the end will pay the bills. It is most important to maintain purchasing power by reasonable prices, for only in that way can we maintain production itself. This must be done through efficient processes and equipment so, despite temporary inequalities, the new law will eventually work in the direction of technical progress.

EDITORIALS

The All-Industry Code

CHEMICAL INDUSTRY'S code of fair competition, printed in full in this issue, is worthy of the attention of every individual in any phase of chemical activity. It is a simple, straight-forward, workable bill of rights immediately applicable in all parts of the industry. If every company will sign it and join with the Chemical Alliance in its enforcement, that action can not help but make for sound conditions in chemical industry. Then the subsidiary groups and subdivisions can and should work out the supplementary codes to cover their own particular problems and practices. A united industry is the first step toward the recovery.

Where Haste Saves Waste

AS WE GO TO PRESS several groups of equipment makers in the chemical field are joining the struggle to evolve codes of fair competition with which to effectuate the policies of the NIRA. Among them, the Heat Transfer Institute and organizations among the centrifugal manufacturers and the suppliers of oil industry equipment are ready to go, while others, notably the makers of general process equipment, are being urged to form a chemical equipment association for the purposes of the recovery act. In every case, unless some simpler plan of action can be devised, each group as it is formed will have to complete its code and rush it to Washington for review, public hearings and final approval.

During the latter part of June, in Chicago, a step was taken to form a coordinating association for that part of the capital goods industry which does not logically fit in elsewhere. This group, the Machinery and Allied Products Institute (MAPI for short), is indubitably a move in the right direction, for its purpose is to gather together all the trade associations in its field, to assist in the completion of individual trade practice codes for the several component associations, and to develop a general code, covering mandatory matters, for the entire industry. When completed, MAPI will represent an industry which is among the first five in importance in the country. As such, it will be able to pursue the just interests of individual groups far more effectively than they could themselves. In gaining recognition for the status of the capital goods industries, MAPI has already shown its mettle. As it grows, it may confidently be expected to assume an importance fully equal to such powerful groups as the Iron and Steel Institute and the National Electrical Manufacturers' Association.

Here then is a case for haste to save waste. While possibly the needs of some groups may not fit into the scheme of MAPI, most chemical equipment associations should find their problems greatly simplified through prompt cooperation with it. Much needless milling around in Washington can thus be saved and better codes can be formulated and put through the stages of approval without in any way submerging the identities of individual groups.

Which Shall It Be N, K, or P—or All Three?

TENNESSEE VALLEY AUTHORITY is required, by the law that created it, to make and market fertilizers on a scale sufficiently large to determine the costs of manufacture and the prices at which fertilizer should be sold to the consumer. Therefore, some of the most serious and immediate of its problems are those relating to the supply of fertilizer chemicals, and the extent to which it shall undertake plant operations or new process development in the Valley.

Recent chemical engineering developments have partially answered these questions. Domestic sources of synthetic nitrogen on a large scale have been assured for some years past. The renewed activity of the steel industry has again released a flow of byproduct ammonia in itself adequate to take care of our demands. Thus the nitrogen problem can well be solved by the purchase of this commodity from commercial sources. We are led to believe that TVA is contemplating such procedure which precludes, at least temporarily, the operation of the cyanamide plant at Muscle Shoals.

Potash from California and from the two successful mining operations in New Mexico gives assurance of generous domestic supplies from these mineral sources. But their distance from Middle Tennessee—the center of fertilizer consumption—is an evident handicap that is likely to whet the TVA interest in other forms of potash recovery, for example, as a byproduct from cement manufacture by the new process described in *Chem. & Met.* last month or by other volatilization processes using locally available minerals.

Phosphoric acid made according to the new ideas developed at the Fixed Nitrogen Research Laboratory certainly deserves more serious consideration. The suggestion that TVA should go ahead, either by itself or in cooperation with certain willing industrial groups, on a substantial work-scale trial of these ideas is sound. No one need to assume that this means a direct entry of the Government in the phosphate chemical business. It can, and probably should, restrict its effort to the making of products suitable for fertilizer use on such a scale as would permit careful determination of their actual commercial cost. The products so made will be a logical basis for the experiments in agronomy, soil improvement and fertilizer utilization, which are specifically provided for in the Act establishing TVA.

When a sound basis for industrial operations has been fixed, then we may expect that public-spirited groups prepared to carry out these processes regularly will arise and make proposals that can be considered by the Authority before it ventures further into commercial operations. Ultimately it is to be hoped that commercial manufacture will be under private auspices

adequately inter-related to existing chemical and fertilizer industries. That, however, is a bridge which TVA will not have to cross for some time to come.

Standardization Must Not Lag Now

WITH THE ANNOUNCEMENT last month that Government economy measures have made it necessary to transfer certain activities in simplification, commercial standards, safety and building codes from the Bureau of Standards to the American Standards Association, a change in a considerable part of our standardization procedure became necessary. But at the same time, industry received, through the Association, an opportunity greater than ever before for its effective self regulation. The move is one that is well within the spirit of the National Recovery Act.

How successful this regulation will be depends very largely on the continued and increasing support which industry must accord the Association. After its 15 years of existence, A.S.A. is now supported by 37 nationally active member bodies and numerous companies and individuals. Some 475 organizations and industrial concerns are actively cooperating in the development of standards. The Association is serving both as a national and an international clearing house for standards in many fields. Of the nearly 400 projects so far undertaken, well over 200 have already resulted in standards and others are on the way to completion.

No reasonable doubt of the value of such an organization can exist. Whole-hearted support from all of industry is the price that must be paid if the added burden is to be carried properly and if we are to make the most of our opportunities.

Alky Gas Still Packs Political Power

WHEN THE SENATE Finance Committee pigeonholed the proposal for compulsory mixing of alcohol with gasoline, then masking under the guise of a tax measure, many thought the matter was settled. But the ardent supporters, self-appointed representatives of the corn-farmer, have continued to advocate alky gas apparently as a measure of political self-advancement.

Tests made under the direction of the Bureau of Standards and reports of responsible automotive engineering groups at various times have confirmed what was previously well understood, that addition of alcohol, though in some measure beneficial, results in decreased fuel efficiency for practically all types of motor cars. The major benefit gained is from the anti-knock value of the alcohol. Despite these conclusions, well substantiated both in theory and practice, there remain among the backers certain of the Iowa State College proponents, the farm leader advocates, and most of the corn-belt Congressmen. But in connection with the Iowa State College group it should be pointed out that there is clearly as radical a difference of opinion in Ames as in Washington. It is interesting to note that the chemical engineers seemingly do not share the judgment of some of the Extension Service, who glibly pass over certain chemical engineering facts and lay great stress on the *half* of the curves which they say prove their argument as to the superiority of alky gas.

No one should object to the vigorous development of alcohol as a motor fuel when considered on its merits; but we see no reason for a refusal to accept scientific facts. As one Government official said, "If the fuel is superior and the farmers can, as they claim, get 3 cents per gallon more for it, why do they not do so?" It is unfortunate that certain technical groups have allowed their sincere desire to assist in the development of non-food and non-feed uses for corn, to carry them beyond sound technical and economic facts. There is nothing to be gained in the end by such procedure.

Chemical industry must watch this situation. It is not to be expected that Federal legislation can secure any serious attention soon; but state legislatures are not so easily protected from unsound findings.

New Patent Law Needed To Protect Private Industry

WHEN A GOVERNMENT employee does research, even as a part of his regular employment, and it results in patentable invention, he may personally exploit the results for private profit. The Supreme Court has thus spoken, and there is no higher authority.

This is an amazing decision with the justice of which many may quarrel. Certainly most industrial executives are going to share the judgment of the minority of the Court which held that the results of Government investigations belong to all the public without question or without right of interference by the individual Government worker. But we must remember that this was a minority finding, and that the majority judgment of the Court prevails.

Some observers, including competent attorneys, appear to have confused this case affecting Government employees with other lower court decisions bearing on the contract rights of employees of private corporations. In the latter cases, there has been an evident desire of the courts to extend the rights of the employer to cover patentable inventions even when the conditions of employment did not altogether specifically provide for ownership of such discoveries. Whatever may be the significance ultimately of this trend, it does not affect the matter of inventions resulting from industrial research by the Federal Government.

Only new legislation by Congress can protect industry against exploitation by individual Government workers who may choose to exercise the rights thoroughly defined for them in this Supreme Court case. Such a new law is greatly needed. It should be drafted and submitted to a wide variety of interested critics. Then it should be introduced into Congress and vigorously pressed for enactment next winter.

THE CHEMICAL CODE

What It Is—and the Wartime Chemical Alliance Revived to Put It Into Effect

CHEMICAL INDUSTRY, stirred by an emergency comparable to that which in August, 1918, led to the creation of the Chemical Alliance, has revived that wartime organization in order to present a united front in carrying out the purposes of the national recovery act. Fortunately the original charter was still in effect and its board of directors generously offered its use in the present emergency. This offer was accepted on July 18 and a group of chemical executives headed by William B. Bell, president of the American Cyanamid Co., proceeded immediately to reorganize the Chemical Alliance as an all-industry agency for meeting the requirements of NIRA.

A new constitution was drawn which makes it possible for "any individual firm or corporation engaged in the manufacture of chemicals in the United States" to become a member on the approval of the board of directors and the payment of the nominal dues of $10 per year. Other provisions govern the election of officers and members of the board, the appointment of an executive committee and the holding of an annual meeting on the first Monday of November. Voting power of the membership is in accordance with a scale based on the number of employees on the member's payroll. Application blanks and full information can be obtained from Mr. Bell's offices at 535 Fifth Avenue, New York City.

In a letter addressed to the executives of all the chemical trade associations and institutes on July 25, Mr. Bell stated that the Chemical Alliance did not propose to interfere with any existing organizations in the field, and he pointed out that each such group or division might, if it desired, submit its own divisional code to cover trade practices and its own particular problems—provided only that it did not interfere with the general code of the industry. That code, drafted by a committee under the chairmanship of Lammot duPont, is published in full elsewhere on these pages.

Officers of the Chemical Alliance, Inc., members of the board of directors, and the principal committees were announced by Mr. Bell as follows and it is understood that all except two or three have accepted their responsibility:

Officers: William B. Bell, president; Charles Belknap, vice president; Willard H. Dow, vice president; Lammot duPont, vice president; Orlando F. Weber, vice president; J. W. McLaughlin, treasurer, and Warren N. Watson, secretary.

Executive Committee: E. M. Allen, Charles Belknap, Horace Bowker, E. W. Clark, W. H. Dow, Lammot duPont, Glenn Haskell, G. W. Merck, August Merz, J. W. McLaughlin, A. E. Pitcher and W. D. Ticknor.

Code Committee: Lammot duPont, chairman; W. B. Bell, A. K. Hamilton, G. W. Merck and J. W. McLaughlin.

Statistics Committee: E. V. O'Daniel of the American Cyanamid Co., chairman; Leonard T. Beale, Willard H. Dow, J. B. Ford of the Michigan Alkali Co. and W. D. Ticknor.

Board of Directors: E. M. Allen, Mathieson Alkali Works, Inc.; L. T. Beale, Pennsylvania Salt Mfg. Co.; Charles Belknap, Monsanto Chemical Works; W. B. Bell, American Cyanamid Co.; Horace Bowker, American Agricultural Chem. Co.; E. W. Clark, The Barrett Co.; H. L. Derby, American Cyanamid & Chem. Corp.; Peter Dougan, Merck & Co., Inc.; Willard H. Dow, The Dow Chemical Co.; R. H. Dunham, Hercules Powder Co.; Lammot duPont, E. I. duPont de Nemours & Co.; J. P. Elkinton, Philadelphia Quartz Co.; J. N. Forker, American Tar Products Co.; T. S. Grasselli, The Grasselli Chemical Co.; C. P. Gulick, National Oil Products Co.; Ernest K. Halback, General Dyestuffs Corp.; A. K. Hamilton, Franco-American Chem. Works; Glenn Haskell, U. S. Industrial Alcohol Co.; H. O. C. Ingraham, General Chemical Co.; S. W. Jacobs, Niagara Alkali Co.; F. J. King, Linde Air Products Co.; Leland Land, Atlas Powder Co.; A. F. Lichtenstein, Ciba Co., Inc.; B. A. Ludwig, National Aniline & Chem. Co.; G. W. Merck, Merck & Co., Inc.; August Merz, The Calco Chemical Co., Inc.; J. W. McLaughlin, Union Carbide & Carbon Corp.; A. E. Pitcher, E. I. duPont de Nemours & Co.; Edgar Queeny, Monsanto Chemical Works; F. W. Russe, Mallinckrodt Chemical Works; C. A. Saunders, Cadillac Soo Lumber Co.; John Stauffer, Stauffer Chemical Co.; Irving Taylor, Michigan Alkali Co.; William B. Thom, Westvaco Chlorine Products Corp.; W. D. Ticknor, Commercial Solvents Corp.; E. T. Trigg, John Lucas & Co., Inc.; John Watson, Int. Agricultural Corp.; Orlando Weber, Allied Chemical & Dye Corp.; E. H. Westlake, Tennessee Copper Co.

TO PRESENT CHEMICAL CODE

William Brown Bell, 54-year-old president of American Cyanamid, astute corporation lawyer and metropolitan banker, champion yachtsman (NY-40 ft. class, L. I. Sound Yacht Racing Association, 1928, 29, 30. Winner of the King's cup in Spanish Ocean Race, 1928). As head of chemical industries' most representative organization—the Chemical Alliance, Inc., will present its case for a master code.

THE ALL-CHEMICAL-INDUSTRY CODE

HERE, briefly, is the chronology of the chemical code. Directly following the M.C.A. meeting at Shawnee, June 1, the executive committee of that organization began to study the requirements of the recovery act and early recognized the fact that a single broad agency must be effected to speak for chemical industry. This led to the revival of the Chemical Alliance already described. Simultaneously work was started on a chemical code which on Aug. 3 was discussed by the board of directors of the Chemical Alliance in an all-day session at the Hotel Biltmore in New York. Numerous changes were made. Then on Aug. 8 the code was informally presented to General Williams, and after incorporating further suggestions, it was mailed to members of the industry for their approval and signatures. Date for a public hearing has not been announced but if sufficient signatures are received immediately, NRA may possibly permit its use instead of the blanket agreement, pending final action by industry and government.

CODE OF FAIR COMPETITION FOR THE CHEMICAL INDUSTRY

TO effectuate the policy of Title I of the National Industrial Recovery Act, the following provisions are established as a Code of Fair Competition for the Chemical Industry.

Article I

Definitions—(a) The term "Chemical Industry" as used herein shall be construed to include all manufacturers of any chemical product in establishments, or any part or parts thereof, covered by this Code. Subsidiaries which conduct manufacturing operations or services in

conjunction with the operations of the parent company may be included.

(b) The term "Alliance" as used herein means The Chemical Alliance, Inc., a non-profit sharing corporation organized and existing under the laws of the State of Connecticut. A copy of the Constitution and By-Laws of said corporation is attached hereto marked "Appendix A." The membership of said corporation is representative of the Chemical Industry.

(c) The term "employees" as used herein means all persons employed in the establishments, or any parts thereof, covered by this Code.

(d) The term "effective date," as used herein, means the tenth day after this Code has been approved by the President of the United States.

Article II

Hours of Labor—On and after the effective date, no person employed within the Chemical Industry shall be permitted to work more than an average of 40 hours per week during the

TO RECEIVE CHEMICAL CODE

Clarence Charles Williams, 64-year old major general, wartime chief of ordnance in A.E.F., U. S. Army retired; former inspector of powder manufacture in duPont works, awarded D.S.M. in 1919, Commander Legion of Honor (French), Commander St. Michael and St. George (British), Commander Order Polonia Restituta (Polish). As Deputy Administrator of N.R.A. will preside at Chemical Code hearings.

effective period of this Code nor more than 48 hours during any week, but such limitations shall not apply to:

(a) Any person employed in an executive, administrative, supervisory and/or technical capacity, or as an outside salesman;

(b) Any person employed as repairman, engineer, electrician, loader, truck driver, cleaner or watchman; provided that, no person specified in this sub-paragraph (b) shall be permitted to work during any three months period a total of more than ten per cent in excess of the total hours during any three months period determined by the average of 40 hours per week.

(c) Those departments or divisions of the Chemical Industry in which season or peak demand places an unusual and temporary requirement for production upon such departments or divisions, except that in such cases no employee shall be permitted to work more than an aggregate of ten per cent in excess of the average of 40 hours per week above provided.

(d) Employees engaged on continuous operation at places where adequate supply of qualified labor is not available and cannot reasonably be made available and where restriction of hours of such employees would unavoidably reduce production. In such cases the average weekly hours may not be in excess of 48 hours per week.

(e) Cases of emergency, provided that at the end of each calendar month any such employer in the Chemical Industry shall report to the Chemical Alliance, in such detail as may be required by the Executive Committee, the number of man hours so worked, giving the emergency reasons therefor, and the ratio which such emergency man hours bear to the total number of man hours during said month.

THE CODE AT A GLANCE

Hours and Wages: Forty hours at 40 cents for entire U. S. A. excepting men in executive, administrative, supervisory and/or technical capacities or in continuous operation at places where qualified labor is not available—then 48 hours the maximum. Where hourly rates on July 15, 1929 were less than 40 cents but above 30 cents that minimum to prevail. Apprentices to receive not less than 80 per cent of minimum. No child labor.

Statistics: Data necessary for NIRA to be collected by confidential agency not connected with any member of chemical industry. Open-price provisions optional with sub-divisions.

Administration: Chemical Alliance, Inc., set up as administrative agency to hear complaints, coordinate industry subdivisions, receive and recommend supplementary codes and amendments.

Article III

Minimum Wages—On and after the effective date the minimum wages paid by any employer in the Chemical Industry to any employee, including accounting, clerical, office and sales employees, shall be not less than 40 cents per hour, or at the rate of 40 cents per hour if paid on other than an hourly basis, unless the hourly rate for the same class of work on July 15, 1929, was less than 40 cents per hour, in which latter case the minimum wages paid shall be not less than the hourly rate paid on July 15, 1929, and in no event less than 30 cents per hour, except that

(a) The minimum pay for apprentices shall be not less than 80 per cent of the minimum pay provided above, but apprentices shall not be paid less than the minimum regular pay after one year of employment.

(b) The minimum pay for service employees (such as watchmen, gatemen and porters) shall be five cents per hour less than the minimum wage hereinbefore provided for.

In the case of any employee whose compensation is based upon a measure other than time, the total compensation paid shall be no less than such employee would be entitled to receive if his compensation were measured by a time rate.

Article IV

Child Labor—On and after the effective date, no employer in the Chemical Industry shall employ any person under the age of sixteen years.

Article V

Administration—The Alliance is hereby appointed an agency for the following purposes:

(a) To collect from the members of the Alliance all data and statistics which may be called for under this Code, or required by the President, or reasonably pertinent to effectuate Title I of said Act. Any data and/or statistics of a confidential nature shall be collected by a firm of Certified Accountants or other suitable agent selected by the Alliance, and not a member or connected with a member of the Chemical Industry.

(b) To represent the Chemical Industry in conferring with the Administrator with respect to the application of this Code and of said Act, and any regulations issued thereunder, and hear complaints, and if possible adjust the same, and to coordinate the administration of this Code with such codes, if any, as may affect any subdivision of the Chemical Industry, with a view to providing joint and harmonious action upon all matters of common interest, and to receive any proposals for supplementary provisions of amendments of this Code or additional codes applicable to the Chemical Industry or subdivisions thereof; provided, however, that as regards all matters mentioned in this paragraph (b) said Alliance shall not have the power in any way to bind the Chemical Industry or any sub-division thereof.

(c) The duties of the Alliance above enumerated shall be exercised by action of its Board of Directors and/or its members as provided in its Articles of Association, Constitution and By-Laws. The Alliance may delegate any of its duties to such agents and committees as it may appoint, whose personnel, duties and powers may be changed by the Alliance from time to time.

Article VI

Any establishment operating under the provisions of this Code which is not a member of the Alliance shall pay to the Alliance a share of the expenses of the administration of this Code on the same basis as if it were a member.

Article VII

If any employer in the Chemical Industry is also an employer in any other industry, the provisions of this Code shall apply to and affect only that part of the business of such employer which is a part of the Chemical Industry.

Article VIII

Employee Organization and Bargaining—(a) Employees shall have the right to organize and bargain collectively through representatives of their own choosing, and shall be free from the interference, restraint, or coercion of employers of labor, or their agents, in the designation of such representatives or in self-organization or in other concerted activities for the purpose of collective bargaining or other mutual aid or protection.

(b) No employee and no one seeking employment shall be required as a condition of employment to join any company union or to refrain from joining, organizing, or assisting a labor organization of his own choosing.

(c) Employers shall comply with the maximum hours of labor, minimum rates of pay, and other conditions of employment, approved or prescribed by the President.

Article IX

Nothing in this Code shall be interpreted in such manner as to impair in any particular the constitutional rights of the employee and employer to bargain individually or collectively as may be mutually satisfactory to them, and nothing in this Code shall prevent the selection, retention or advancement of any employee on the basis of his individual merit without regard to his affiliation with any labor or employee organization.

Article X

The President of the United States may, from time to time, cancel or modify any order, approval, license, rule or regulation issued under Title I of the National Recovery Act.

Article XI

Amendments or Additional Codes—Supplementary provisions or amendments to this Code or additional codes or fair trade practice rules applicable to sub-divisions of the Chemical Industry may from time to time be submitted in behalf of the Chemical Industry or any subdivisions thereof for the approval of the President.

Article XII

Any sub-division of the Chemical Industry, recognized by the Alliance, operating under the provisions of this Code may elect, in accordance with the Constitution and By-Laws of its association or institute, or if no association or institute exists, as the members of such subdivision may determine, to sell its products only upon open prices, terms and conditions publicly announced by each member of such sub-division. Any changes in prices by any member of such sub-division shall be announced by such member immediately to all other members of the subdivision through such agency as the sub-division may determine. Variations from such open and publicly announced prices, terms and conditions shall not be allowed.

Article XIII

By presenting this Code, and the specific provisions of Articles II and III thereof, those who have assented hereto shall not be bound by any modification thefeof, except as each shall thereto subsequently agree.

Article XIV

The provisions of this Code shall expire on December 31, 1933, or on the earliest date prior thereto on which the President shall by proclamation, or the Congress shall by Joint Resolution, declare that the emergency recognized by Section I of the National Industrial Recovery Act has ended.

Making Sulphur in City Gas A Profitable

A modified liquid purification process for removal of sulphur from city gas provides marketable sulphur as a byproduct. This article interprets the chemical engineering aspects of the problem. The data used to illustrate the economic relations are those calculated by Fred Denig, The Koppers Co., Pittsburgh, and first presented by him before the Production Conference of American Gas Association in New York City late in May.

TWO NUISANCES may make a profitable byproduct. This is the interesting possibility appearing in the development of the ammonia-thylox gas purification process as installed by The Koppers Co. at the Racine, Wis., plant of Wisconsin Gas & Electric Co.

This process recovers sulphur in elemental form suitable for the manufacture of sulphuric acid. The idea is that the acid so made may then be used for fixing the ammonia in the gas as marketable ammonium sulphate. Sulphuric acid, the principal item in the cost of this byproduct chemical, would therefore be materially cheapened; and an opportunity for profit from its recovery thus would be restored despite low market prices.

The ammonia-thylox process differs from its predecessor, the soda-thylox process, in the use of ammonium thioarsenate instead of sodium thioarsenate as the absorbing solution. The gas is passed up through a grid-filled absorber tower through which this solution flows. The usual condensing and ammonia-removal equipment precedes this scrubber. Approximately 99 per cent removal of the H_2S is accomplished, and final cleaning of the gas is then done in a dry-oxide box purifier.

The thylox solution from the base of the tower is pumped to the top of an actifying tower called a pressure thionizer where it is revivified by blowing air up through it. The air decomposes the sulphur compound and releases elemental sulphur in a finely-divided form, which is carried to the top of the thionizer and separated in a skimming tank as a thin slurry. The air leaving this thionizer is practically free from any odorous constituent and occasions no nuisance even when the gas plant may be located in a closely-built part of the city.

Sulphur slurry overflows from the skimming tank at the top of the thionizer to the storage tank from which it is fed to a continuous rotary filter. The sulphur filter cake is discharged into a steam-jacketed autoclave where it is melted down and separated from the entrained solution. The molten sulphur may then either be cast into blocks of suitable size for shipment or it may go under pressure directly to the sulphur burners in a nearby acid plant.

In order to maintain the thylox solution of the proper concentration and slightly alkaline makeup ammonia is added. This may be done either by bypassing a small

Cake sulphur after treatment in autoclave

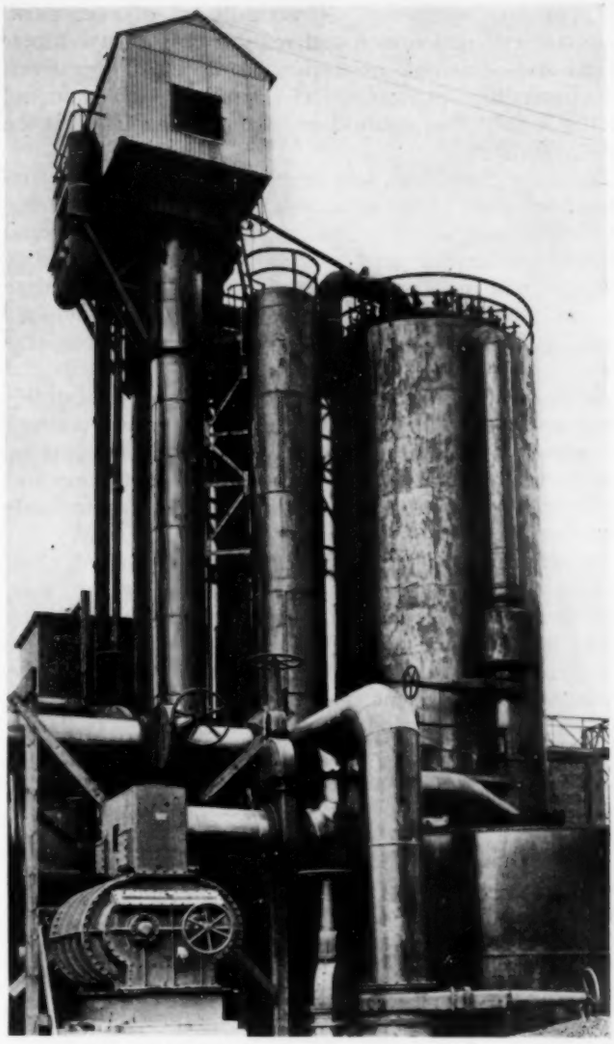
Byproduct

By R. S. McBRIDE
Editorial Representative, Chem. & Met.

quantity of gas containing ammonia around the saturators or by addition of weak ammonia liquor. The Racine plant uses the latter method. Another installation uses the former. There appears to be no advantage in favor of the one method over the other, except local preference and convenience of connections. In plants where some ammonia is recovered as vapor from the fixed-ammonia stills, this may be used conveniently for makeup. In such cases, the steam from the still also furnishes a large part of the heat required for warming the solution at the exit of the saturators so that it will enter the thylox absorber at the optimum temperature, usually about 90 deg. F. Makeup of the absorber solution in arsenic content is usually accomplished in the recirculating storage tank controlled by occasional checks in the laboratory, generally once per shift or once per day, the frequency determined by experience.

The concentration of arsenic is maintained at approximately one-half per cent of As_2O_3 by weight in the absorber solution. The consumption is approximately 0.02 lb. of As_2O_3 per 1,000 cu.ft. of gas treated.

The sulphur produced contains a little less than one-half of one per cent of arsenic under normal operating conditions. Except where arsenic-free acid is to be made, this brimstone cake is entirely satisfactory for acid making. It is agreed, therefore, that there will be no difficulty in using this sulphur for acid making either in commercial plants or in special plants built at coke or gas works.



Thylox liquid purification plant, Wisconsin Gas & Electric Co., Racine. Pressure thionizer (small tower) with overflow tank and housing at top; center tower, slurry storage; right tower, absorber; oxide box, lower right

Estimated Operating Cost of Ammonia-Thylox Process Purifying 3,500,000 Cu.Ft. of Coal Gas Per Day

Based on 95 per cent removal from gas containing 350 grains H_2S, and 70 grains HCN per 100 cu.ft.

Item	Dollars per Day	Cents per M Cu.Ft.
Labor—12 man-hr./day at 50c/hr	6.00	0.172
Arsenic—0.01 lb./M cu.ft. at 4c/lb	1.40	0.040
Ammonia—0.07 lb./M cu.ft. at 0c/lb	0.00	0.000
Soda Ash—0.00 lb./M cu.ft. at –c/lb	0.00	0.000
Power—0.08 kw.-hr./M cu.ft. at 1.25c/kw.-hr.	3.50	0.100
Steam—For air compressor (live) 11,750 lb./day at 30c/M lb.	3.50	0.100
For solution heating (exhaust) 3 lb./M cu.ft. at 15c/M lb.	1.60	0.045
Maintenance—0.05c/M cu.ft.	1.75	0.050
Total gross operating cost	17.75	0.507
Less credit for brimstone—1,000 lb./day at $18/ton	9.00	0.257
Total net operating cost	$8.75	0.250c

At the right of the flowsheet (p. 401) is shown equipment for recovery of arsenic from discarded solution. Such discarded solution is made acid with sulphuric acid, thereby precipitating arsenic sulphide. This is filtered out and redissolved in soda, thereby making it available to go back in the system. This is a refinement not used in small plants.

Operating results obtained during the first seven months at the Racine plant are summarized in an accompanying table. Much of the variation from month to month was the result of trying out modified procedures. Uniform operation can easily be maintained in any plant when the preferred conditions have once been determined.

The ammonia-thylox process requires no new types

of operating equipment. Practically all of the operations are self-maintained and require only casual supervision and occasional inspection by the plant operatives. The procedures proven entirely satisfactory in plant use of the soda-thylox method are directly adaptable to the new absorbent.

In many plants the only item of labor not easily furnished by other plant operatives would be in the filtering and autoclaving of the sulphur. The value of recovered sulphur, either for acid making in the coke works or for sale, will more than offset this item of cost. There are no plant nuisances created either in this sulphur handling or in the original absorber and actifier operation.

In many plants the existing equipment of hurdle-filled scrubbers, liquor circulating pumps, and tankage are adequate for the process. The installation cost is, therefore, often wholly that involved in reconnection and rearrangement of the plant flowsheets, except for sulphur-handling facilities.

In ordinary coal gas made by either retort or oven processes, the sulphur content is slightly greater than equivalent to the ammonia present, assuming that both are to be recovered in the form of ammonium sulphate. An accompanying chart shows this relationship on the assumption of different gas yields and typical H_2S content and ammonia production. For example, if 24 lb. of ammonium sulphate is expected per ton of coal and 11,000 cu.ft. of gas are made, it requires approximately 410 grains of H_2S per 100 cu.ft. of gas for an equivalent sulphur yield.

Another chart on the basis of typical assumptions as to material and labor costs shows how sulphuric acid constitutes $8.30 out of a total estimated producing cost per ton of ammonium sulphate, regardless of size of plant. This acid cost of $8.30 per ton, 60 deg. Bé. acid, is typical of favorable locations. In many cases the acid cost is a larger part of the total.

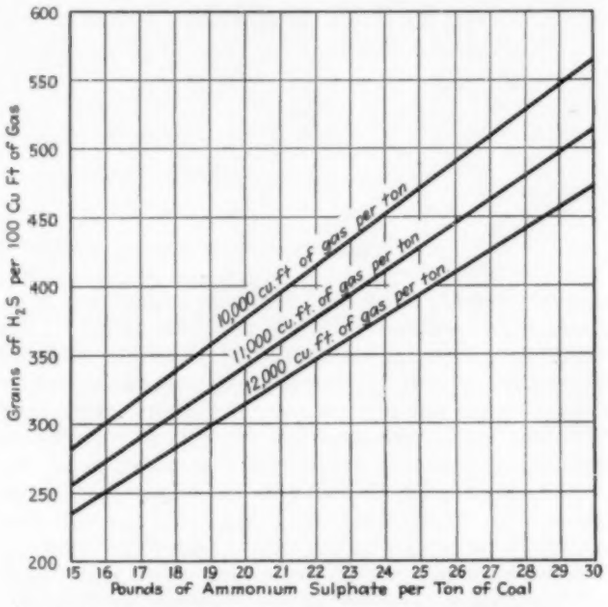
This chart also makes evident the fact that for many typical conditions the present-day cost of ammonium sulphate is greater than the market price, usually not over $20 per ton, f.o.b. plant. Thus under present conditions of acid use, ammonia often occasions a costly product disposal problem rather than constitutes a valuable by-product. Under the typical conditions chosen for this chart, prepared by Fred Denig, of The Koppers Co., such a plant would have to carbonize nearly 3,000 tons of coal per day in order to make ammonia recovery profitable rather than costly.

The economic advantages of this new process may

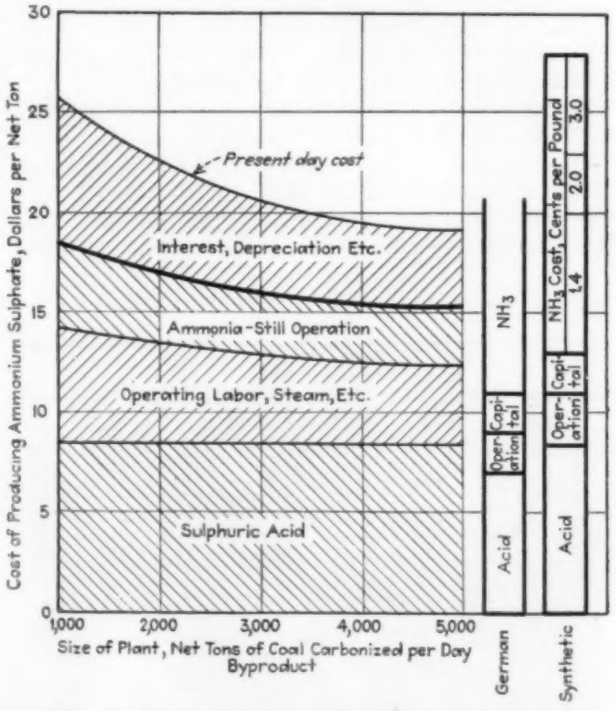
Estimated Total Cost of Purifying Coke-Oven Gas by Ammonia-Thylox Process in Conjunction With Manufacturing Sulphuric Acid

30,000 M cu.ft. per day of gas (300 gr. H_2S/100 cu.ft.
Daily sulphur production—4.6 net tons
Daily sulphuric-acid production—14.3 tons 66° B.

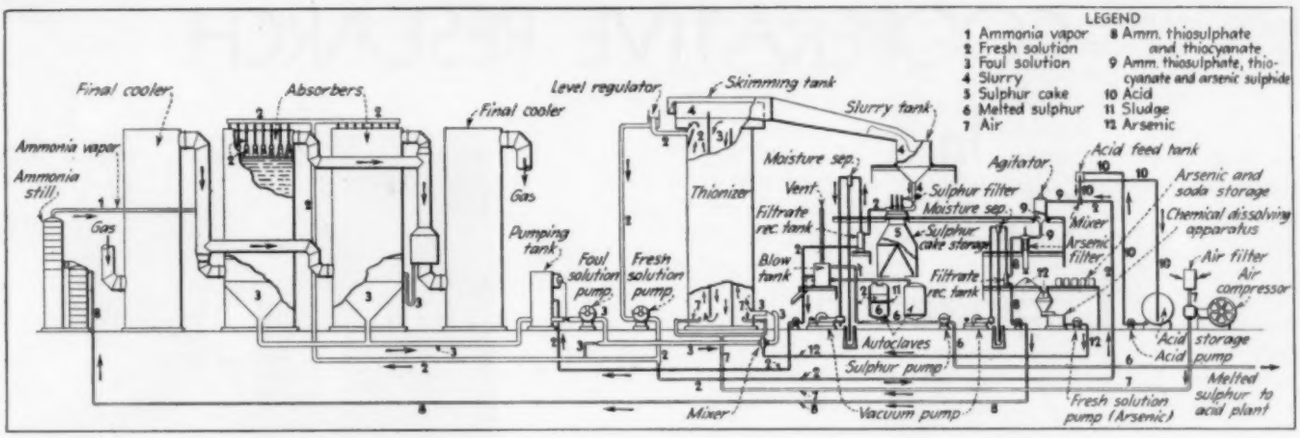
	Cost: Cents per M Cu.Ft. Gas	Cost: Dollars per Ton 66°B. Acid
Purification Plant		
Labor and supervision	0.04	0.84
Steam	0.03	0.63
Power	0.11	2.31
Arsenic	0.02	0.42
Maintenance	0.04	0.84
Total operating cost	0.24	5.04
Capital charges	0.18	3.78
Total cost	0.42c	$8.82
Acid Plant		
Labor and supervision	0.05	1.09
Power	0.02	0.40
Water	0.01	0.15
Maintenance	0.02	0.50
Total operating cost	0.10	2.14
Capital charges	0.10	2.10
Total cost	0.20c	$4.24
Purification and Acid Plants		
Total cost	0.62c	$13.06
Credit allowed for purification	0.80c	$16.80
Net final *credit* for joint operation	0.18c	$ 3.74


Grains of H_2S per 100 Cu Ft of Gas
600
550
500
450
400
350
300
250
200
10,000 cu.ft. of gas per ton
11,000 cu.ft. of gas per ton
12,000 cu.ft. of gas per ton
15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Pounds of Ammonium Sulphate per Ton of Coal

Estimated cost of producing ammonium sulphate



Quantity of H_2S in gas corresponding to various ammonium sulphate yields. Assume sulphate contains 25 per cent NH_3, and acid consumption of 1 lb. 60 deg. Be. per 1 lb. of sulphate



Diagrammatic flowsheet for thylox liquid purification process at a large coke plant

be considered either from the standpoint of the net cost to the company of sulphur removal or on the theory that the main objective is the furnishing of sulphur for acid making. For the former system of calculation, one should charge against sulphur recovery all costs involved and then allot a credit for the sulphur recovered and sold. The preceding table prepared by Denig summarizes these items for a coal-gas plant handling 3,500,000 cu.ft. of gas per day on the assumption of 95 per cent removal from gas containing 350 grains of H_2S and 70 grains HCN per 100 cu.ft.

Under the assumed conditions, the purification cost of such a plant will be just one-quarter cent per M. This is substantially less than in most such small works. The comparison is equally favorable in large works where the labor item per unit of gas handled becomes significantly smaller.

One may prefer to calculate on the theory that the objective of operations is the making of sulphuric acid. Then one applies the table on page 400, estimated by Denig for a larger plant handling 30,000,000 cu.ft. per day of gas containing 300 grains of H_2S equivalent to 4.6 net tons per day of sulphur.

From this calculation it is evident that if the present cost for sulphur removal from gas is 0.8 cent per M, the credit from the acid-plant operation would be nearly 0.2 cents per M. In other words, the acid made would cost less than nothing and be available for ammonium sulphate manufacture under these credit conditions.

Such extreme of favorable economics, of course, would not be found everywhere. But under many circumstances this sulphur recovery procedure will afford substantial economy in the acid costs. Of course, in many moderate-size and smaller plants, it would not be economical to install acid-making equipment. There the sulphur would presumably be sold to the acid maker, for credit against the gross cost of the acid purchased. Geographic relations to the acid plant patronized and the prevailing market for sulphur, of course, determine the net costs or advantages.

Monthly Operating Data on Ammonia-Thylox Gas-Purification Process at Racine, Wis.
SEPT., 1932 — MARCH, 1933

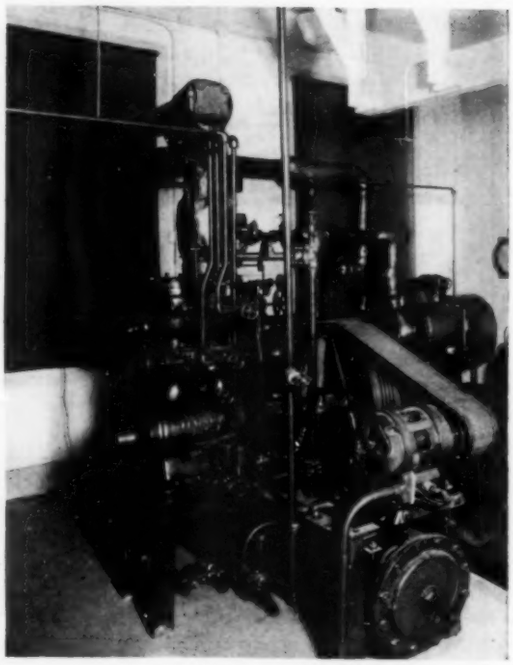
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Average (7 mo.)
Gas purified (M cu.ft./day)	5,056	4,928	4,996	5,245	4,981	5,159	4,764	5,018
Temperature — inlet gas (°F.)	(a) 82	(a) 92	(a) 68	71	65	65	65	73
Temperature — outlet gas (°F.)	92	88	83	81	80	77	82	83
Temperature — solution (°F.)	96	96	95	99	99	96	99	97
H_2S content — inlet gas (gr./100 cu.ft.)	304	305	337	324	306	321	315	316
H_2S content — outlet gas (gr./100 cu. ft.)	13	4	8.7	10	13	8	3	9
H_2S removal (%)	95.7	98.7	97.4	96.9	95.7	97.5	99.0	97.2
HCN content — inlet gas (gr./100 cu.ft.)	20	25	(b) 14.6	(b) 1	(b) 1	....	....	12
Solution circulation (gal./hr.)	17,400	16,000	16,000	16,700	14,100	18,200	19,000	16,771
Solution circulation (gal./M cu.ft.)	83	78	77	76	68	85	96	80
Air consumption (M cu.ft./hr.)	23.4	12.0	11.4	13.0	21.8	19.7	13.4	16.4
Air consumption (cu.ft./M cf. gas)	112	58	55	59.5	105	92	67.5	78
Ammonia consumption (lb./M cu.ft. gas)	0.055	0.063	0.051	0.056	0.055	0.046	0.076	0.057
Arsenic consumption (lb./M cu.ft. gas)	0.036	0.023	0.020	0.025	0.022	0.010	0.009	0.021
Steam consumption (lb./M cu.ft. gas)	2.2	4.3	7.9	6.75	3.97	5.30	5.46	5.1
Scrubber backpressure (in. H_2O)	⅛	⅛	¼	⅜	⅜	⅜	⅛	⅛
Sulphur recovered as salable brimstone (% of total)	62.3	66.0	61.3	....	73.7	(c) 54.2	66.5	64.0
Specific gravity of solution	1.170	1.135	1.123	1.123	1.164	1.118	1.126	1.137
pH of foul solution	7.4	7.6	7.6	7.7	7.8	7.8	7.8	7.7
As_2O_3 in solution (%)	0.40	0.88	0.74	0.90	0.65	0.53	0.59	0.67
Fixed NH_3 (g.p.l.)	34	35	....	....	53	....	....	41
S_2O_3 as $Na_2S_2O_3$ (g.p.l.)	197	106	....	....	131	....	....	145
CNS as NaCNS (g.p.l.)	170	150	....	....	144	....	....	155
Total NH_3 salts (g.p.l.)	141	151	....	....	230	....	....	174
Total soda salts (g.p.l.)	217	95	....	....	141	....	....	151
Actification of foul solution (%)	....	45	....	....	....	....	....	45
Actification of actified solution (%)	....	69	....	....	....	....	....	69
O_2 absorption — first thionizer (%)	3.5	12.8	....	....	....	....	....	8.2
O_2 absorption — second thionizer (%)	8.2	17.0	....	....	....	....	....	12.6

(a) Part of steam added directly to gas before absorber. (b) Cyanogen-washer operating. (c) This low value was caused by irregularities in operation, and is not typical.

COOPERATIVE RESEARCH In Chemical Engineering

By D. B. KEYES

Head of the Chemical Engineering Division, University of Illinois, Urbana, Ill.



Refrigeration and air conditioning equipment, showing compressor, condenser, brine cooler and air dehumidifiers

COOPERATIVE research in chemical engineering at the University of Illinois has been confined to fundamental industrial problems in various fields. Experience has shown that the university cannot handle satisfactorily the ordinary commercial research problem for a particular industrial concern. The problem must be of a broad nature so that more than one industrial concern will be interested and preferably more than one industry. It must also be of such a fundamental nature that the research organizations of the particular cooperative industry are not equipped to handle the problem, principally due to a lack of time at their disposal and secondly because of inadequate staff.

The success of these investigations at the University of Illinois is due largely to the careful selection of the problem and the type of men who have been hired to do the actual research work. It has been found, for example, that in attacking these fundamental problems a basic knowledge of chemistry, physics and mathematics is absolutely essential, and men who have not only their Ph. D. degree but also experience in industrial research are needed. The unique feature of the work at the university has been the employing of special research professors to take charge of each problem instead of the more common procedure of permitting the teaching staff to handle the work as an extra curriculum matter.

So far, the funds obtained have been sufficient, not only to employ the skilled research worker to take immediate charge of the project, but also to employ graduate students and seniors working on a part-time basis. This has increased the size of the graduate school.

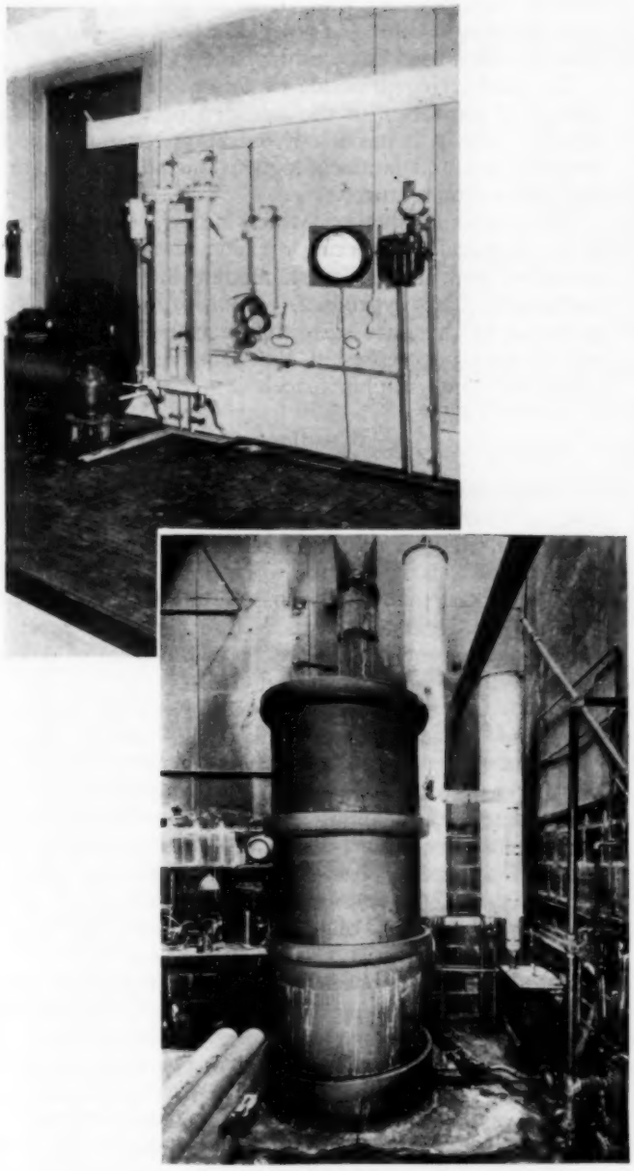
Considerable permanent equipment and in a few cases temporary buildings have been purchased or constructed from these funds. This has naturally increased the physical assets of our division. It has been found quite desirable in several cases to erect small buildings, expressly designed for the particular work. The research operator has the privilege of changing the building at any time to suit his convenience.

The patent situation has been rather complicated as it is in all state universities, but no serious difficulties have arisen as yet. The state university receiving funds primarily from the citizens of the state is naturally in no position to go into the business of making inventions and selling patents to private corporations. They are, however, obligated to the public to the extent of making certain that all research results produced within their laboratories should be available to the public, not only of the state but of the United States. In order to maintain this policy it is sometimes necessary to obtain patents and to see to it that these patents are not smothered but are, on the other hand, developed to the point where the public at large can take full advantage of the results. This has been done in the past by entering into an agreement with the cooperating agent at the time the patentable ideas appear. The cooperating agent guarantees to develop the idea to a practical conclusion, making use of the process or product within its own organization on a royalty free basis. On the other hand, it seems advisable to license the use of the patent to others. This is also done through the cooperating agent. The royalties charged are nominal and the royalty is split with the university on some basis agreeable to both parties. This rather simple method of handling the patent situation whenever it arrives has so far been found to be quite acceptable to both the university and the cooperating agent.

A brief description is given below of some of the outstanding results obtained by the cooperative research here in the chemical engineering division at the University of Illinois.

The synthesis of benzaldehyde from benzene and carbon monoxide may be classified as a special case of

Abstract of a paper presented before the meeting of the American Institute of Chemical Engineers, Chicago, Ill., June 14, 1933.



Experimental gas washing plant

the Friedel-Crafts reaction, using aluminum chloride as a catalyst. One molecule of benzene unites with one molecule of carbon monoxide to form one molecule of benzaldehyde. This reaction does not go readily with any appreciable yields at ordinary pressures. It is necessary to operate, consequently above atmospheric pressure. The reaction is interesting because it should be possible to produce benzaldehyde by this method free from injurious impurities such as chlorine or other chemicals now employed in the common two-step process.

An exhaustive study was made of the following variables: (a) carbon monoxide pressure, (b) temperature, (c) ratio of reactants, (d) time, (e) effect of added constituents, and (f) agitation.

The results of this investigation by Prof. N. W. Krase showed, as was expected, that an increased carbon monoxide pressure resulted in increased conversion of benzene to benzaldehyde. For commercial purposes it is not necessary to exceed a pressure of about 2,000 lb. per sq.in. in order to get a conversion of approximately 60 per cent. The reaction runs smoothly and rapidly at room temperatures, while at higher temperatures undesirable side reactions take place.

One of the important factors in controlling the yield of benzaldehyde by this process is the ratio of aluminum chloride to benzene initially present. The higher the ratio, the more rapid and more complete the conversion to benzaldehyde. For commercial purposes it is felt that a 1:1 molal ratio is entirely adequate. An interesting conclusion was that impurities normally occurring in commercial benzene had a marked effect on the reaction. Complete details of the investigation appear in *Ind. & Eng. Chem.*, May, 1933.

Cellulose acetate rayon and cellulose acetate plastics are hampered in their use because of the present high cost of producing acetic acid. The favorite method at the present time of synthesizing acetic acid is from acetylene. Acetylene, in this particular case, is made from calcium carbide and represents a relatively costly raw material. It has long been felt that if a cheaper source of acetic acid could be found, the corresponding process would be welcomed by the industry.

At the present time synthetic methanol can be produced in large quantities at a reasonable figure. It is a well known fact that under high pressure and high temperature conditions carbon monoxide will unite directly with methanol if a suitable catalyst is present and form acetic acid. It was this particular reaction that has been investigated here at the University of Illinois by Professor Krase, and the development carried as far as a pilot plant. It had long been known that metal alcoholates react with carbon monoxide to form the metallic salt of the acid next higher in the series, but for obvious reasons the work at the university was largely confined to the direct reaction between carbon monoxide and methanol.

The early results indicated that methyl formate, which is isomeric with acetic acid, could readily be obtained from these reactants in the presence of certain catalysts. Catalysts for acetic acid synthesis found to be most effective were the stable acids.

A small unit was constructed suitable for carrying out the gas phase reaction between methanol and carbon monoxide in the presence of phosphoric acid impregnated on active carbon. This unit was operated both as a system with straight expansion and as a system with recirculation of the unconverted products. A larger unit built during the last six months of this research had a rated capacity of about one gallon of glacial acetic acid per 24 hr. Both theoretically and by actual experiment it was shown that it was not necessary to exceed a pressure of around 2,000 lb. per sq.in. in order to obtain satisfactory results.

It was also found that a high ratio of carbon monoxide to methanol was desirable, and the best operating temperature for the catalyst used was in the neighborhood of 350 deg. C. The concentration of the acetic acid in the product varied with the operating conditions from 5 to 50 per cent by volume.

Certain devices suitable for the measurement and control of operating variables were developed as a byproduct of this investigation. A high-pressure gas flowmeter for the measurement of the rate of flow of recirculated gas in a closed system is of particular interest.

Removal of Sulphur Dioxide From Waste Gases

Sulphur dioxide, as a constituent of flue gases, has caused serious pollution of the atmosphere in many localities. The famous Meuse Valley episode attracted the interest of the entire world. It was proven that sulphur dioxide from nearby industries was oxidized under the peculiar atmospheric conditions to sulphuric acid, and later rained down on the inhabitants of the valley with disastrous results.

It is a well-known fact that sulphur dioxide in the air corrodes buildings and equipment. It was with this particular thought in mind that investigations were started by Prof. H. F. Johnstone at the University of Illinois several years ago.

It is recognized that the mere washing of flue gases containing a small percentage of sulphur dioxide with water is not economically feasible. The quantity of water required is roughly 75,000 gal. per million cu.ft. of gas for each type of washer.

It was thought that if the sulphur dioxide could be converted to sulphur trioxide in the water solution by means of the oxygen present in the flue gases, it might be possible to use far less water because of the lower partial pressure of the sulphur trioxide or sulphuric acid. This, of course, necessitated the use of a catalyst in the water solution.

Unfortunately, because of the slow absorption of oxygen, the use of the oxidation method is only profitable when bubble washers can be used. In this particular case the contact required is one-sixth of that required in a more simple absorber.

Another obstacle in the application of the oxidation method to flue gases is the poisoning effect of certain compounds on the oxidation reaction. In spite of this fact, the use of water containing catalysts is far more efficient than pure water.

Efficiency of Alkaline Solutions

The sulphuric acid produced, of course, is in a dilute form. Therefore, it is doubtful that large quantities of such acid could be disposed of profitably. On the other hand, the disposal of these weak acid solutions in enormous quantities might involve a serious expense. The general conclusion concerning the oxidation method is, therefore, that it is only feasible for waste gases when the scale of operation is relatively small. Some application of this process to refinery gases and other chemical fumes has been reported.

The rate of absorption of sulphur dioxide from the flue gases by alkaline solutions has been measured in a packed tower washer, and found to be nearly 50 times the rate in the oxidation process. A contact time of less than one second is required for approximately complete absorption. The chief disadvantage in using these alkaline substances has been in the cost of the chemical which, in the case of lime, may reach $1.00, based on a ton of coal burned.

It is quite possible, however, to make use of the high absorptive rates of alkaline solutions and regenerate the absorbing agent by heating to approximately 200 deg. F. Several salts of ammonia have already been found to have a high capacity when used in this way, absorbing and liberating as much as 6 per cent by weight of sulphur dioxide when used for washing flue gases.

The underlying principle of this process consists in a change of ionization of the acid produced from the salt. In other words, it has a low ionization constant at a low temperature, and a much higher ionization constant at the higher temperatures.

This particular method, which is now being developed in the chemical engineering division of the university, is attractive both from the standpoint of economics and mechanics. The byproduct, sulphur dioxide, which is produced in the pure state, has a considerable market, and it does not represent the problem of disposal as would the dilute sulphuric acid.

Miscellaneous

Among the other interesting cooperative projects that have been carried on in the chemical engineering division has been a study of possible methods of sulphur removal from coal. This laboratory work done by Prof. R. D. Snow indicated that it was possible under special conditions of oxidation and reduction to eliminate approximately 90 per cent of the sulphur in the form of hydrogen sulphur from finely divided coal.

An exhaustive study has been made in both the vapor and liquid phase catalytic oxidation of simple organic compound using air as the oxidizing agent. It has been found that the heat conductivity of the catalyst is an important factor controlling the reaction. Various new catalytic chambers have been designed for laboratory purposes. The reaction between oxygen and ethyl alcohol has been studied from a catalytic standpoint. Some knowledge has been obtained as regards the proper catalyst, for this particular type of reaction.

Difficulties have appeared in house heating plants using gas as a fuel, caused by a disintegration of mortar between the bricks, presumably due to the presence of sulphur acids in water condensed in the flues. A study of this situation has been made by Dr. A. C. Robertson.

An investigation covering the tendency of certain waters to form a scale within boiler tubes under high pressure conditions has been undertaken by Prof. F. G. Straub. Details of the work have been published (*Ind. & Engr. Chem.*, Vol. 24, pp. 914, 1174, and 1416; *Trans.* of the A.S.M.E. Vol. 54, p. 221).

One of the results of the investigation originally conceived by Prof. S. W. Parr and done by Professor Straub on embrittlement of boiler plate has been the recommended use of sodium sulphate for the prevention of embrittlement by the Boiler Code Committee of the American Society of Mechanical Engineers. A complete report of the work is given in Bulletin 216 of the Engineering Experimental Station, University of Illinois.

Results of research work done on production of ice by Prof. Dana Burks, Jr., have been published in Bull. 212, 253, 254 of our Engineering Experimental Station.

Financial assistance for some of this work has been given by the Utilities Research Commission of Chicago and the Chemical Foundation.

What Steel to Use At High Pressures and Temperatures

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The effect of hydrogen and the gradual continuous distortion of most materials of construction under continuous load make it unsafe to use at elevated temperatures the usual rules of design

THE AUTHOR endeavors to discuss in a practical way two problems in materials of construction made important by the growing commercial requirements for high pressures and temperatures, especially in dealing with hydrogen. The basic facts concerning the behavior of metals at high temperature are stated.

There are also mentioned certain compositions which offer particular advantages in specified ranges of temperature, and suggestions made for permissible stresses, which, it is to be noted, must be modified to meet particular cases.

The two metallurgical problems considered are:

(a) *Creep*—the gradual continuous distortion of metals under continued load below that producing prompt fracture—making it unsafe to use at elevated temperatures the usual rules of design based on tensile strength or proportional limit;

(b) *Hydrogen corrosion*—the effect of hydrogen at high pressures and temperatures on the constitution and structure, and consequently upon the properties, of metals.

Until comparatively recently it was assumed that, up to their proportional limits, steel and other metals followed Hooke's law, but is now known that at temperatures sufficiently elevated, steel under surprisingly light loads continues to extend for a very long time. This phenomenon is called "creep."

With refinement of measurement it has become a question if metals are ever rigid bodies and really not always viscous, continuing to yield to even the smallest stress at rates that usually are wholly imperceptible. This, steel almost certainly does at all temperatures above that at which strain-hardening is released. When a piece of steel is strained there occurs, shortly, an increase of hardness and a higher elastic limit, provided the surrounding temperature is not so high as to produce an equal softening effect. This limiting temperature varies with the composition and treatment of the steel, is generally about 375-475 deg. C., but is occasionally considerably higher, 540 or above.

Up to this temperature a slightly overpowering stress is met by an increase of resistance, and no measurable creeping extension occurs. As the temperature rises, the ultimate tensile strength and the proportional limit, with rare exceptions, fall—the latter much the more rapidly—and the stress-strain curve becomes so rounded that it is difficult to assign a yield point. Young's modulus of elasticity also falls.

If we examine a slow time-extension test curve for a manganese-molybdenum steel, we observe first an instantaneous extension, nearly all or entirely elastic, the elastic part immediately recoverable on release of the load, blending into an extension partly elastic and slowly recoverable, partly viscous and irrecoverable, followed by a period of viscous flow at a fairly constant rate. If the loading be sufficiently prolonged this flow continues until reduction of the section, or some other cause, produces an increase of the rate, shown by an upward turn of the curve, which proceeds to fracture with increasing rapidity.

It is to be noted that a slow rate of extension is not proof that a change of rate can not shortly occur. As all mechanical constructions contemplate a reasonable life, which is rarely less than two or three years, clearly a creep test should be maintained as long if it is to furnish completely reliable data. Generally this is impossible in view of the time and labor involved, and one must be content with the results of tests extending at the most to a few thousands hours, remembering when using the

Based on a paper, Metallurgical Problems in Handling Hydrogen Under High Pressures and Temperatures, presented June 15, 1933 before the Chicago, Ill., meeting of the American Institute of Chemical Engineers.

data to make due allowance for the unexpected that may happen.

As the temperature increases at constant load, or the load at constant temperature, the initial extension increases and the curve turns upward the sooner; the material has shorter life. For material highly stressed, the change of life may occur somewhat suddenly.

For steels used near the strain-hardening limit, a moderate increase of temperature is usually more destructive in its effects than is a proportionate increase of stress, and in general it is so at higher temperatures; a fact to be borne in mind when designing new apparatus or imposing more severe operating conditions on old apparatus. The effect of high temperature in shortening the life of equipment is well illustrated by Fig. 2, a series of "iso-flow" rates showing how the stress must be reduced at rising temperatures to produce an estimated flow of one per cent over various periods of time, for a carbon steel. It is evident that a short run at high temperature is more destructive than a much longer run at lower temperatures. It also appears that if a piece of apparatus need have but a short life, a high stress can be used, but if the life must be long it will pay to use heavier sections with lighter stresses, in spite of increased first cost.

Creep Test Methods

Eager search has, of course, been made for short-cut methods of making creep tests, for it takes several months to secure proper data at one temperature on one composition or physical state, even with multiple apparatus. Since as yet there is no known definite relation between the usual short time test and the long time creep, all short creep methods involve the assumption of creep long continued at the rate measured in a short time, often not over 48 hr. While the results may hold good for a long time, there is no assurance that they do, and in many cases they do not so hold. Preferably such test should be continued for fully 1,000 hr. to avoid the extreme extrapolation often employed.

Chemical composition is of as much importance in resisting stress at super-atmospheric temperatures as at lower temperatures. Within the strain-hardening range carbon is considered to increase resistance to strain up to about 0.4 per cent, with but little gain above that figure on long time tests, which is different from its hardening power in short tests. Being readily oxidizable, carbon steels are unfit for use much over about 480 deg. C. If used, due allowance must be made for loss of section by scaling.

Experience shows, and Chevenard's experiments prove, that an alloy more nearly approaches a rigid body than does a pure metal, and preserves this property at a higher temperature; also that, generally speaking, small additions of strengthening elements are more effective proportionately, than large additions, and that small additions of several elements are more effective than an equal addition of a single element.

Among the lower alloys for use at moderate temperatures, one of much promise is a low carbon-manganese-chrome-molybdenum steel, which at 480 deg. C. shows in 700 hr. at 20,000 p.s.i. no extension as great as one fifty-thousandth of an inch. At 25,000 p.s.i. it has a creep rate of about 0.2 per cent in 1,000 hr.

Nickel alone, in moderate proportions, has little effect on the creep values of steel. Tapsell, Johnson and Clenshaw found a 3.43 per cent nickel steel no better than plain 0.50 carbon steel at 400 deg. C. and above.

Chromium is active in raising creep strength. It is the basis of most heat-resisting alloys, increasing strength and decreasing oxidation. At about 5 per cent, combined with 0.5 per cent Mo in a low carbon steel, it has over twice the creep strength of carbon steel at 540 deg. C., and offers fair resistance to oxidation and to corrosion in sour oils. Stainless iron, carrying about 0.10 per cent C, and 15 per cent Cr., has somewhat over twice the creep strength of a plain 0.11 per cent carbon steel from 400 to 500 deg. C., and fair strength above that range, besides a good degree of resistance to oxidation.

The straight chromium steels with higher Cr possess greater creep strength and resistance to oxidation, but have very low impact strength and are liable to great

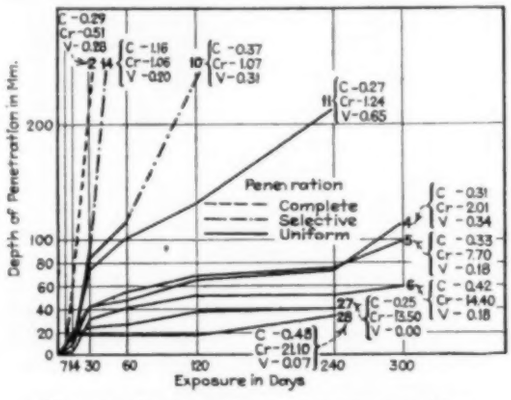

Fig. 1—Penetration of chrome-vanadium steels by 8.3 per cent ammonia in nitrogen-hydrogen mixture at 500° C. and 100 atm. (Vanick, deSveshnikoff & Thompson)

coarsening of the grain on long exposure to heat. A small addition of nickel helps to restrain this growth.

Combined with nickel in varying proportions, chromium produces the best commercial refractory ferrous alloys available in quantity today. They can be further strengthened by small additions of Mo, W, Ti, and others. The well-known alloy "18-8," having from 18 to 20 per cent Cr and 8 to 10 per cent Ni, has excellent creep properties. It belongs to the class of austenitic alloys, having a face-centered cubic lattice, whereas ordinary steels are body-centered. Although the austenitic alloys are comparatively soft at atmospheric temperature, they are much more slowly softened by heat than is the other type, and are far stronger at high temperatures. For use at medium-high temperatures the 18-8 alloy should have a very low carbon, and should not be given the usual high quench if it is to be used in the range of about 510 to 700 deg. C., in which it may otherwise become embrittled and suffer intergranular weakening. At higher temperatures the carbides precipitated in this dangerous temperature range, which are the cause of the trouble, are in solid solution, permitting the use of higher carbon and a cheaper raw material. Titanium in small quantities is reported largely to correct this intergranular weakening.

For severe conditions even higher ferrous alloys are used such as Hadfield's HR-1, Commentry-Fourchambault & Decazeville's BTG, the alloy used for catalyst

bombs in the Claude process for synthetic ammonia, operating at a temperature of about 565 deg. C. and at a pressure of about 1,000 atmospheres producing a fiber stress of about 25,000 p.s.i.

The choice between dominant nickel or dominant chromium in ferrous alloys may depend on the chemical exposure. High nickel can not be used in a sulphurous atmosphere without injury.

To date it has not been feasible to run along time creep tests at temperatures over about 760 deg. C. because of damage to the apparatus by such long continued heat. Above this temperature it is customary to use a percentage of the short time tensile strength based upon experience, largely in furnace work, where a life of two or three years is all that is expected, and where probably from 3 to 5 per cent of stretch would make little or no

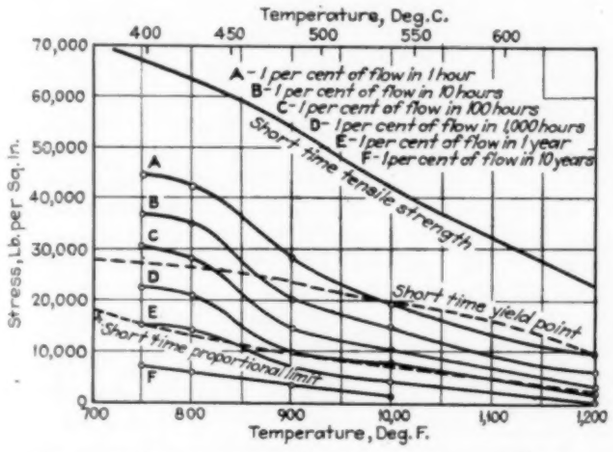

Fig. 2—Iso-flow rate curves for carbon cast steel (Kanter & Spring)

difference. The Midvale Co. suggests the following percentages of figures obtained from specimens held 1 hr. at temperature and broken at 0.06 in. per min., a faster rate of pulling will give higher figures.

Temperature °C.	Percentage of tensile strength at that temperature
750	13.5
800	12
850	11
900	9
950	7
1,000	4.5
1,050	3
1,100	2.4

Practical Applications of Research Data

The choice of the factor of safety to be used in any design where creep will be encountered is largely a matter of judgment. Where possible personal or property risk is slight, a lower factor can be used than where the risks are greater. Length of expected service permits a choice among rates of flow which will be guided by permissible alterations of dimensions. With the exception of some of the most highly alloyed, almost every ferrous structural alloy not embrittled by its exposure might be expected to show 8 to 10 per cent extension, at least, when broken hot; it would then seem that about 5 per cent of flow could reasonably be expected in ordinary cases before the danger line was reached, provided it could be tolerated.

To insure freedom from any probable change of creep rate it is advisable to use less than the full stress producing it on test; two-thirds of that stress is suggested as a reasonable allowance. Factors of safety should be used to cover inexact calculations of stresses, inferior workmanship, excess operating temperatures or pressures, and so forth.

Hydrogen Corrosion

The growing use of hydrogen at elevated temperatures and under pressures running up to 15,000 p.s.i. has added another difficulty to the problem of securing satisfactory materials for high temperature service.

According to Hüttig, (G. F. Hüttig, *Z. angew, Chem.*, vol. 39, pp. 67-75) hydrogen may combine in three ways, as electropositive or electronegative ion or as a metal. With the groups containing carbon, nitrogen, oxygen and fluorine it forms stable gaseous hydrides of fixed composition, its maximum reactivity being with the halogens. With the alkali metals hydrogen produces compounds somewhat of the nature of salts, where it behaves as an electronegative. With most of the metals of the second, third, sixth, seventh and eighth groups, those containing aluminum, magnesium, chromium, manganese and iron, hydrogen forms metallic hydrides of no fixed or definite composition, but combinations which resemble alloys or solid solutions, varying continuously. No combination is known of hydrogen with manganese, nor any stable combination with chromium.

Bassett (W. H. Bassett, A.S.T.M. Symposium on Effect of Temp. on Properties of Metals, p. 351) states that heated in hydrogen or gases containing hydrogen, at and above a red heat, copper is penetrated by hydrogen, the oxide which it contains is reduced, and the material is seriously embrittled. Deoxidized copper and copper alloys are not affected by hydrogen in this way.

With iron hydrogen forms a hard, brittle hydride, not yet produced free of uncombined iron. In ferrous metallurgy, in addition to its embrittling action, hydrogen causes trouble by attacking and removing carbon, by reducing oxides, and by producing cracks and fissures. The effect depends upon its state, whether atomic or molecular, upon the composition of the metal attacked, and upon the temperature and pressure, varying directly with the latter two.

At 500 deg. C. and atmospheric pressure, high-carbon steel suffered no decarburization in molecular hydrogen in an exposure of one week. At the same temperature and 1,250 p.s.i., the skin carbon of a 1.40 per cent carbon steel was reduced to 1.10 per cent in 16 hr. As the pressure increases the rate of attack rises with it, and the skin carbon falls almost to zero.

In 16 hr. at 500 deg. C., with 3,000 p.s.i. pressure, the surface carbon was reduced from 1.40 to 0.10 per cent. At .04 in. from the surface the carbon was 0.20 per cent. Continuing the exposure to 48 hr. reduced the carbon to that figure at a depth of .052 in. The rate of attack falls off with decrease of carbon, a three-fold exposure increasing by only 30 per cent the depth at which the same carbon is found. Under the same conditions a strip of 0.05 per cent carbon steel was completely decarburized in 168 hr.

At 700 deg. C. and atmospheric pressure, ordinary mild steel is rapidly decarburized by molecular hydrogen and suffers intercrystalline injury. The rate of attack in-

creases with the temperature. Cold working of the metal is also conducive of increased attack. Alloy steels are more resistant than carbon steels to hydrogen.

In a series of tests (private communication) lasting 168 hr. at 500 deg. C. and 3,000 p.s.i. of still hydrogen Nitralloy G, and certain samples of 18-8 showed slight decarburization. The last alloy can be considered immune to hydrogen attack under these conditions.

Chrome - vanadium, chrome - vanadium - aluminum, chrome-nickel-vanadium-aluminum steels, stainless steel, 18-8, 24 per cent Cr—20 per cent Ni, and BTG metal (Cr, 12; Ni, 60; W, 2.5) were completely resistant. In service the 24-20 alloy has been exposed without failure for many thousands of hours to high-pressure hydrogen at temperatures as high as 440 deg. C. BTG metal is regularly used at temperatures as high as 565 under pressure of 1,000 atm. of hydrogen, with a fiber stress as high as 25,000 p.s.i., and failure occurs after a life measured in thousands of hours, provision being made that failure shall not result in an accident.

Hydrogen-Nitrogen Mixtures

At the present time a principal use of hydrogen is for the synthesis of ammonia from its constituent gases under pressure and temperature conditions ranging from 1,500 to 4,500 p.s.i. at from 400 to 500 deg. C., up to 15,000 p.s.i. at 560 deg. C. The conditions present a serious problem, much more difficult than when hydrogen alone is present. Its importance has led to a vast number of experiments, in striking contrast to the paucity of those on hydrogen alone. Every feature of the hydrogen attack is present in greatly intensified form—complicated by nitriding—the worst effect being the extensive fissuring produced in many steels. A carbide network may be eaten out and volatized, destroying most of the coherence of the grains.

Henderson in conjunction with Beilby (*J. Chem. Soc.*, vol. 79, p. 1245), and later with Galletly (*J. Soc. Chem. Ind.*, vol. 27, p. 387) found that Fe, Co, Ni, Cu, Zn, Mn, Cr, Mo, W, Ti, Sn, Pb, Cd, Al, Pd Au, Ag, Pt, all either formed nitrides or suffered profound modification of physical properties in a current of ammonia, given suitable conditions of temperature, even without increase of atmospheric pressure, and believed that all metals are so affected.

Early in the development of its method for synthesizing ammonia, the General Chemical Co. tried a number of materials in the form of bottles filled with a nitrogen-hydrogen gas mixture and held at 1,500 p.s.i. and 500 deg. C. until failure with the following results, according to Wheeler (*Trans.* A.I.M.E., vol. 67, p. 257):

Material of Cylinder					Time under test before failure
Type of Steel	C	Ni	Cr	V	
Plain carbon	0.35	....	....	....	4 mo.
Carbon chrome	1.06	....	0.65	....	4 mo.
Nickel	0.43	3.50	....	....	6 mo.
Chrome-vanadium	0.54	....	1.00	0.38	Over 2 yrs.

The problem was studied by Wheeler at the Watertown Arsenal in 1917-18 on a wide range of ordinary and special steels, using 650 deg. C. and atmospheric pressure. Because he did not use operating pressures, his results are not of quantitative value, but it is interesting to know that he found low carbon a necessity; that the resistance of chromium steels increased with increasing Cr content but not in proportion to it; that V offered some resistance; that Ti, W and Mo in small quantities had an effect like Cr; that Mn, Si, Ni, Al, U, B and Zr had either no effect or were harmful; that W was the only pure metal tried that was not seriously affected.

The work was continued by Vanick, de Svesnikoff, Thompson, Cottrell, Larson and their successors at the Fixed Nitrogen Research Laboratory in Washington. In general the results of their work agreed with Wheeler's. Their first tests, lasting four months, were on a wide variety of steels at 500 deg. C., 100 atm. pressure, in a gas composed of nitrogen and hydrogen in the proportions of N_2: $3H_2$ containing 8.3 per cent ammonia, (near but somewhat below equilibrium). These tests indicated that carbon steel was worthless, being rapidly decarburized and fissured; that in all cases low carbon was desirable; that nickel steels were subject to a peculiar type of extensive longitudinal fissuring concentric with the axis of the specimen and highly undesirable, even though the metal showed comparatively little alteration of properties in the longitudinal direction; that in low-chromium steels oxides were reduced, carbides decomposed, nitrides formed, and fissuring occurred after a slight decarburization—following grain boundaries where pronounced—and that added resistance accompanies increased chromium if the chromium-carbon ratio increased. The best results were shown by a tungsten-chromium steel of 0.58 per cent C, 0.55 Cr, 1.6 W, in spite of high carbon and low chrome, and promising results by a commercial chrome-vanadium steel. It also appeared that a longer test might reverse the showing of a two weeks' exposure, and that although exposure to cracking ammonia gave plain surface indications, that was not the case at synthesis, serious weakening being possible without apparent injury.

Chromium Stopped Selective Penetration

Further tests on a series of ten chrome-vanadium steels under the same conditions, but lasting 10 mo., showed that 2.25 per cent Cr stopped selective penetration and intergranular fissuring; limitation of penetration being caused by a zone of what appeared to be chromium nitride, penetrable but slowly by the gases. It was found that with constant C increasing Cr was beneficial on a descending scale, as appears from Fig. 1.

Steel No. 4, containing Cr, 2.01; V, 0.34; gave results almost identical with steel No. 5, having Cr, 7.70; and V, 0.18. Vanadium was considered to add nothing, but I think the point not proved, and believe beneficial the fine grained structure it helps to impart.

There was a marked decrease in strength and ductility of the specimens, the elongation after exposure being usually less than 2 per cent and in many cases practically zero, though probably much higher at operating temperatures. In practice it has been found that material within a catalyst chamber may be severely embrittled or destroyed without injury to the vessel itself, possibly due to differences of temperature at the same pressure, and I have yet to learn of the failure in service of a chrome-vanadium vessel. Their best results were given by a steel containing C, 0.31; Mn, 0.48; Si, 0.12; Cr, 2.01; V, 0.34.

Tungsten having made a good showing in the earlier tests, a further series of 17 steels was made by the Midvale Steel Co., with W 0.81-11.69 and Cr 0-2.49, together

with a 2.42 Cr -0.20 V, a plain 2.67 Cr, and a 2.20 Cr-29.35 Ni analysis, which were exposed for a year to 10 per cent ammonia in a N_2: $3H_2$ mixture at 300 deg. C. and 600 atm.—a lower temperature and higher pressure than before. Tested for strength and hardness, but not microscopically, a preliminary report (not yet published) says that W materially improved resistance up to 2.85 per cent, with no gain above it, and with lower results at 11.69 per cent. One per cent Cr proved better than tungsten at 0.8 per cent, and, oddly, as good as 2.67 per cent Cr under these conditions. The steel with C, 0.12; Cr, 1.01; W, 3.10 after exposure, showed practically no change in its excellent properties of 72,000 p.s.i. tensile strength, 34,000 p.s.i. yield point, 33 per cent extension in 1½ in. and 55 per cent reduction of area. Just as good was the showing of a heat with C, 0.35; Cr, 1.00; V, 0.07 containing no W.

Commercial copper, not deoxidized, after an exposure of over 1,500 hr. in the N_2: $3H_2$ mixture at approximately 550 deg. C. and 1,000 atm. has had its properties reduced from 30,700 p.s.i. tensile strength, 65 per cent elongation, 50 per cent reduction of area to 25,040 p.s.i. tensile strength, 20 per cent elongation, 18 per cent reduction of area. Under similar conditions phosphor bronze suffered no injury.

Chrome-Nickel Steels Used Abroad

In 500 hr. at the same exposure, Armco Iron was attacked at the grain boundaries, its tensile strength, elongation and reduction of area being reduced to zero. KA-2 alloy before the exposure gave 92,000 p.s.i. tensile strength, 72 per cent elongation, 63 per cent reduction. After 162 hr. in a 75 per cent H_2: 25 per cent N_2 mixture at 500 deg. C. and 1,000 atm., its properties were 62,600 p.s.i. tensile strength, 8 per cent elongation, 18 per cent reduction of area.

According to Saklatwalla (*Metals & Alloys,* vol. 1, p. 8) chrome-nickel steel was used abroad in catalyst chambers for ammonia synthesis, but recent plants are employing chrome-vanadium steel. To the best of my knowledge, in this country chrome-vanadium steel has been used exclusively, the exact proportions varying somewhat according to the size of the vessel, with the average composition running about 0.30 per cent C, 2 Cr, 0.20 V, usually normalized and tempered, the physical properties depending on the exact composition, treatment, and section tested, ranging from 70,000 to 105,000 p.s.i. tensile strength, 35,000 to 75,000 p.s.i. proportional limit, 25 to 20 per cent elongation in 2 in. and from 55 to 40 per cent reduction of area.

In some tests reported by Krupp (private communication) made in a hydrogen-nitrogen mixture at 450 deg. C. and 300 atm. for 630 hr., Monel metal, after exposure, broke in the hand; copper lost three-quarters of its elastic limit, nearly half its extension, and three-fourths of its reduction of area; 18-8 did much better, losing chiefly half its reduction of area; Silcromal, a very low carbon chrome-vanadium-molybdenum steel, was hardly affected. I am not certain of the exact composition of this steel, but believe it to be approximately C, 0.06 max.; Mn, 0.30; P. 0.02 max.; S, 0.02 max.; Si, 0.40; Cr, 5.00; Al, 0.75; V, 0.05; Mo, 0.40.

Another composition, intended for destructive hydrogenation and other reactions with carbonaceous materials, contains C, 0.10; Cr, 6.00; Mo, 0.50. To this the same comments apply as to the preceding alloy.

The BTG metal previously mentioned as being used for most exacting service in the synthesis of ammonia by the Claude process is adapted also for equipment used in the production of synthetic hydrocarbons. It can not be produced in large masses, nor can pieces of considerable size be forged. The Claude cylinders are made as solid castings bored out and heat treated. Their life at a stress of approximately 25,000 p.s.i., at about 560 deg. C. and 1,000 atm., varies from about 2,000 to nearly 20,000 hr.

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Corrosion in Sulphonators

Corrosion tests have been made at the plant of Endicott Johnson Corp. in cooperation with the International Nickel Co. to establish the behavior of metals in sulphonators under actual operating conditions. Specimens insulated from one another were fastened on a spool-type holder, that was submerged within the sulphonator.

In the first series of tests specimens were exposed during the sulphonation of ten batches of neats foot oil by a process in which 66 deg. Be. sulphuric acid was added to the oil over a period of 1 hr. after which the reaction proceeded for about 6 hr. at a maximum temperature of 34 deg. C. At the end of 6 hr. a saturated Na Cl brine was added to the mixture, which was then thoroughly agitated and allowed to settle over night, after which the sulphonated oil was drawn off.

In the second series 66 deg. Be. acid was allowed to react with cod liver oil over a period of 6 hr. after which a 15 per cent brine was added and agitated, allowed to settle over night and then drawn off. The oil was finally neutralized with alkali. Corrosion rates were as follows:

	Corrosion rate-mg. per sq.dm. per batch	
Metal	Sulphonated neats foot oil	Sulphonated castor oil
Lead	127	165
Chrome-nickel iron (18-8)	425	22
Nickel	30	25
Monel metal	34	11
Ni-Resist	90	29
Plain cast iron	10,000	120

Use of De-Airing for Clays and other Plastic Products

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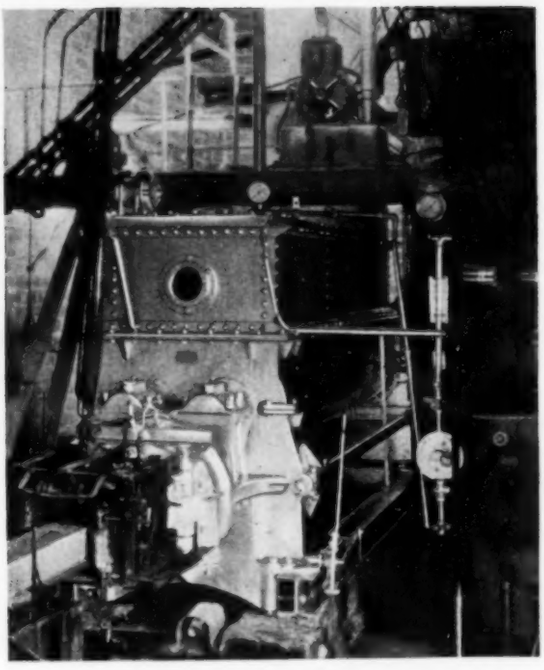


De-airing machine developed by the author and in commercial use at Adel since 1927

IN WHAT FOLLOWS it will be possible to discuss only briefly some of the accomplishments and a few of the possibilities in the de-airing of plastic and non-plastic bodies during processing. De-airing, it will be understood, is defined as the partial evacuation of the air or of any other gases present. The present paper deals largely with clays, for clay is the special field with which the author is most familiar. However, the processes and equipment are fundamentally the same for many other plastics.

Clay is a mass of mineral particles more or less suspended in a covering of colloids which in turn are more or less covered with adsorbed films of air or of other gases—when such gases are present (R. Dubrisay, *Ceramique*, Vol. 35, 1932, pp. 113-7). The mineral particles form what may be termed cores of three-phase colloids which carry static negative charges (F. E. Bartell, Univ. of Michigan). The cohesion between particles is proportional to the electrical attraction which exerts enormous forces within the body. These forces actually seem to compress the entrapped gases (W. B. Hardy, Proc. Roy. Soc., Vol. 66, 1899, pp. 95-109), the escape of which is greatly retarded by the restricted passageways. Laboratory experiments seem to prove that anything done to a clay which brings the cores of the particles closer together increases the strength according to the electrical law of attraction between two bodies.

Following is an equation derived from experimental data which fits the observations:

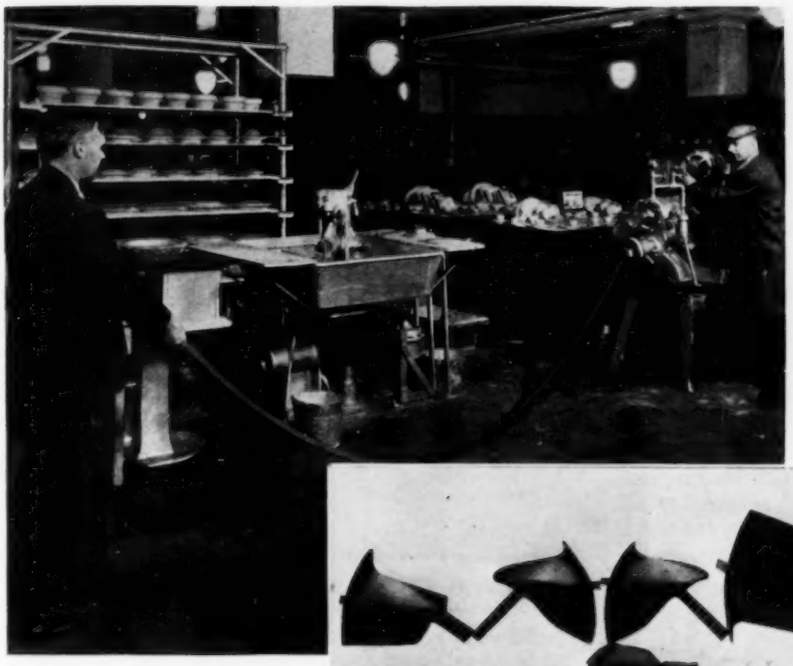
$$Fr = \frac{e^2}{r^2} \quad \frac{p^a}{r(p-1)}$$

In this, r is the distance between the particles, p is about 8, e is the electrical charge on the particles and a is a constant obtainable from experiment. The force of attraction increases as r decreases up to a certain distance, r_0, after which the force decreases to zero; still further decreases bring about a force of repulsion. The distances of the colloids in clays do not seem to become small enough to show a weakening effect so long as the mixture is plastic.

Investigations are now being carried on covering the increases in plastic and fired strength resulting from de-airing in the plastic state with different conditions of molding. It is expected that the law governing strength increases will be determined from grain size and spacing, and modulus-of-rupture tests, under all these different conditions. In most plastic clays the colloidal matter is less than 3 per cent of the entire mass, and the rigid mineral particles permit the application of laws applying to rigid materials. The forces involved in shrinking a clay may be determined from the heat evolved in forcing apart the mineral cores of known size a measurable distance upon the addition of water (C. E. Marshall, Soc. Chem. Ind., London, 1931).

Removal of air films around the colloids allows the cores of the colloids to move into a closer relation, for which reason great increases in plastic tensile strength are to be expected. It is found that an increase of specific gravity not over 8 per cent adds up to 3,000 per cent increase in plastic tensile strength. Fine-grained bodies of clay show decidedly less effect when de-aired than coarse-grained bodies because the former usually contain fewer voids and less air on account of the better classification of aggregate. All clays require more water to attain a plasticity when de-aired equal to that of bodies containing air.

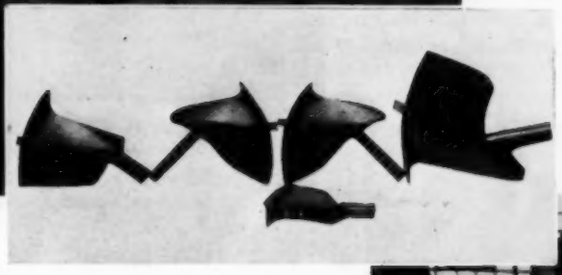
Presented under the auspices of the Process Industries Committee of the American Society of Mechanical Engineers at the society's recent meeting, Chicago, June 29, 1933.

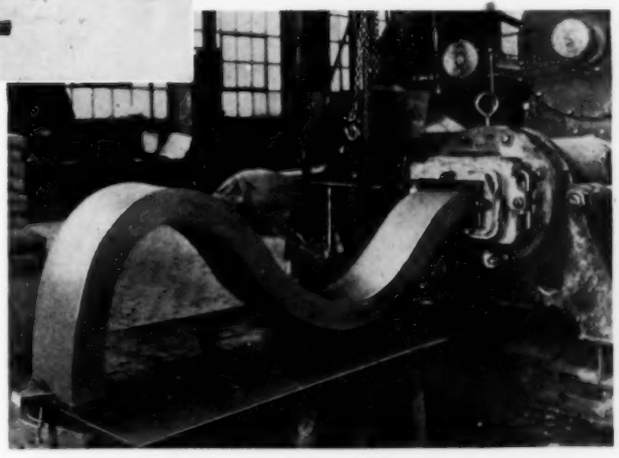


Mr. Straight demonstrating the tenacity of an 18-ft. length of 1x2-in. clay bar as it issues from a small Bonnot de-airing machine

Pugging with the streamlined blades shown at the left gives a degree of de-airing almost equal to vacuum treatment

Below is a view showing the remarkable plastic strength of a brick column extruded from a Bonnot de-airing machine





Most clays show an alkaline reaction and all clays show a negative static charge. Under the ultra-microscope they exhibit a definite Brownian movement of colloids within an alkaline suspension. The removal of adsorbed air in a basic clay seems to limit the Brownian movement and the clay colloids pack more densely.

Under rarefied conditions the air film around the colloids is easily ionized. The idea of using a good vacuum in combination with a source of ultra-violet rays near the vacuum pump inlet is suggested as a possible treatment for dry masses. The rays should serve as guides for the directional movement of the ionized and electrically charged air.

In the ceramic industry machinery has been developed for the effective de-airing of plastic clay bodies in a continuous operation. Augers feed the clay into the de-airing chamber and seal the intake. Pugging knives cut through and work the clay masses ahead while they are in the rarefied atmosphere. The expressing auger used for extruding the clay through the die seals the outlet. The working of the body of clay in the rarefied atmosphere seems to be a necessity if the entrapped air is to be cut loose and good results are to be secured.

Another method of de-airing has also been developed, based on the assumption that if the clay colloids were to be worked under the proper conditions, the electrical attraction between the particles would probably squeeze out a part of the air. This was actually accomplished under ordinary atmospheric surroundings by streamlining the pugging knives so that air would not continually be pumped or lapped into the mass being plasticized. The clay was so greatly improved with this treatment that photomicrographic studies of bodies prepared both by this method and by use of a rarefied atmosphere reveal surprisingly little difference.

In addition to the improvement in strength of ceramic bodies, there are other important improvements that follow from de-airing:

1. The molding of clays into units is accomplished with 5 to 10 per cent less power than where air is present. De-aired clays, it seems, are less resilient.

2. Units made of de-aired clays show less accidental loss in handling on account of the increases in plastic, dried and fired strength.

3. Vitrification of de-aired ceramic bodies is accomplished with less time in firing and at a lower temperature because the fluxes are more active when in more intimate contact with the silicates and aluminates.

4. Ceramic materials subject to abrasion show up to 40 per cent less loss of abraided material when the clay body has been de-aired, on account of the reduction of lamination.

5. Disintegration of ceramic wares from the action of freezing and thawing and chemical crystallization is very much reduced because of the elimination of blisters and lamination.

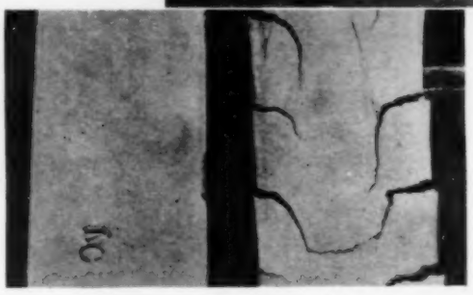
6. De-aired ceramic wares subject to a field of electrical stress show an improved resistance to breakdown

on account of the greater uniformity of the internal structure of units so made.

7. Absorption of moisture in fired bodies of de-aired ceramic wares is much reduced. With perfect de-airing, absorption of moisture would be close to zero where the grain sizes are perfectly proportioned. A reduction of over 50 per cent is now possible commercially.

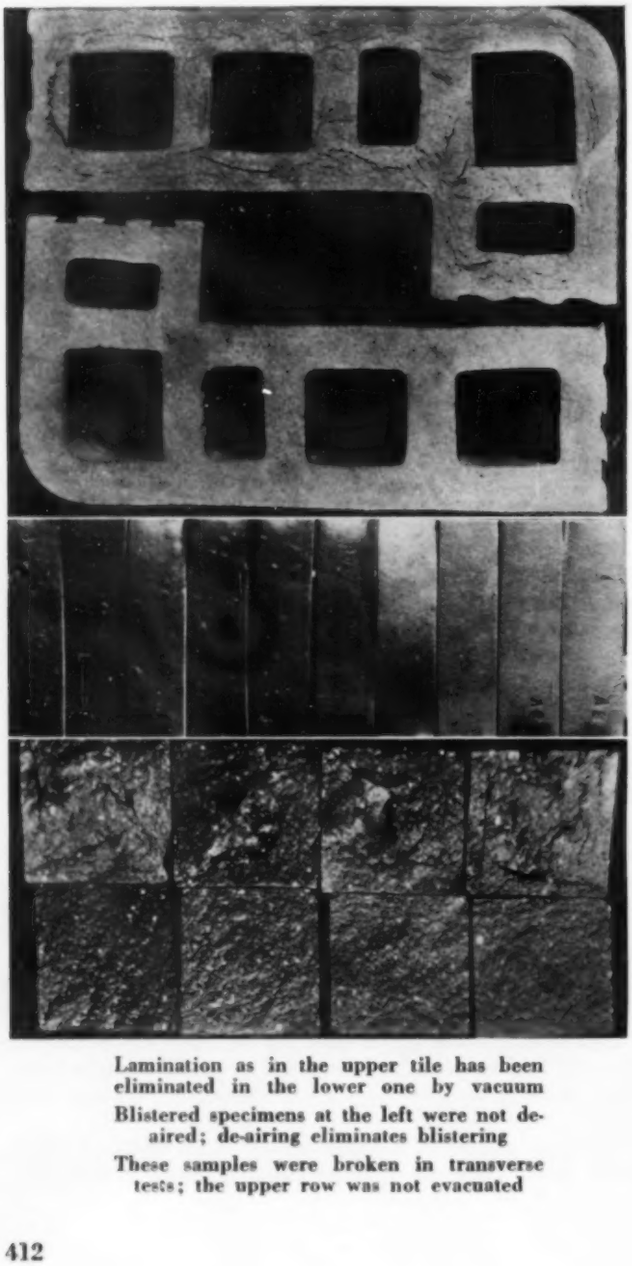
There is one very decided disadvantage to de-airing in the case of some fine-grained clays where the closing up of the passageways by the removal of air films restricts the flow of moisture to the surface under osmotic pressure. In order that moisture may be removed from a clay body it is necessary for some air to flow in to fill the voids enlarged between the mineral cores of the colloids by the shrinkage of the colloidal gel. This was recently shown by Dr. T. K. Sherwood, of M.I.T., who found that close-grained woods which had been thoroughly dried, and then saturated with water containing air, dried faster than the same wood saturated with de-aired water.

All photos in this page supplied by The Bonnot Co.



Plasticity of de-aired clay demonstrated by tension; specimens at left de-aired

Effect of evacuation on column flow in 3 in. x ¾ in. specimens; left sample de-aired



Lamination as in the upper tile has been eliminated in the lower one by vacuum

Blistered specimens at the left were not de-aired; de-airing eliminates blistering

These samples were broken in transverse tests; the upper row was not evacuated

There are many other applications for de-airing outside of the ceramic industry, a few of which may be cited as follows:

Air adsorbed into the body of animal or vegetable fats and oils causes oxidation with the formation of various fatty acids. The application of de-airing to fats would be accomplished in much the same way as in ceramics.

Commercial putty would be much strengthened, rendered denser, and more adhesive, on de-airing.

Writing elements for lead pencils could be made perhaps three times stronger by working the mixture for a considerable period under a high vacuum and ionizing influences before plasticizing and molding.

The covering ability of paints, varnishes and lacquers would be improved by de-airing under vacuum.

Adhesives would show increased cohesive strength within their body, as well as better adhesive qualities, upon being de-aired.

Linoleums and like floor coverings made from cork compounds would, if de-aired, wear better on account of the closer packing and greater strength of the body.

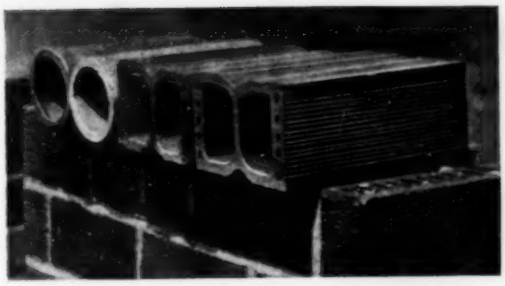
Abrasive wheels de-aired before molding are improved in bond strength; because of higher peripheral speeds, they do better work and show less wear.

Sisal and similar fibers suitable for rope would, if de-aired and impregnated with a suitable filler and lubricant, resist wear better, show greater strength, and longer life.

Optical glass is mechanically stirred for days before being cast into rough forms. The optical properties would be improved if such glass were de-aired during the stirring. Processing time would be reduced.

The emulsion of a photographic film shows distinct evidence of air blisters in the gelatine. Greater sharpness of both positive and negative prints would be achieved if emulsions were prepared under a vacuum. This would be particularly advantageous for the motion picture industry.

Printers inks would be greatly improved in their abil-



Comparison of wire-cut ends of de-aired unde-aired units

ity to make a rapid impression on high-speed presses if they were de-aired. Adsorbed air films in the body of the ink make it necessary to allow added time for the film to move aside before the ink colloids contact the paper.

Sealing waxes and like resinous compounds would be made much stronger if processed in a vacuum. They would adhere more closely to articles such as globe bases in which they are extensively used.

Concrete for pavements and other monolithic bodies can be made stronger, denser, and more watertight if de-aired. There will be less internal strain because of differential shrinkage in setting and less differential contraction and expansion with changes of temperature. Pavements made of concrete so treated will stand more abrasive wear because of closer contacts between the crystals formed and the mineral aggregate.

Ceramic slip glazes are improved by de-airing while they are in the slip condition. As a result, blisters in the matured glazes are eliminated.

It would be possible to mention other de-airing applications but lack of space prohibits. We must draw the conclusion from the known facts that de-airing is simply a means of making possible a more closely packed system within any body, whereby the electrical attraction between colloids is increased, resulting in greater strength in any mass so treated.

In conclusion the author wishes to acknowledge with thanks the valuable suggestions made by Dr. T. K. Sherwood, of the Chemical Engineering Department, Massachusetts Institute of Technology; by Dr. T. D. Yensen, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.; and by C. G. Harmon, of the Ceramics Department of Iowa State College.

▼ ▼ ▼

Greater Purity Gives Iron New Uses

A NEW METAL shows an average analysis of 99.92 per cent pure metallic iron. Other metals as high in iron have been produced commercially, but with each of these some part of the iron has been present in the form of oxide. Svea Metal is the result of research carried out by the Swedish Iron & Steel Corp. The raw material is pure Swedish charcoal iron, a pure grade of wrought iron. It is important to chemical industry from two standpoints. It is a superior raw material for the manufacture of products containing iron. It has valuable qualities as a material for the construction of chemical engineering equipment, process controls and instruments.

As a chemical raw material, the metal is desirable because of freedom from impurities, high content of metallic iron, and lack of iron oxides. Products made with it require less time and expense for refining and are of superior quality. One large chemical manufacturing plant is employing it in the production of copperas and medicinals with satisfactory results.

In general, this new iron enters into the manufacture of two types of products: organic iron compounds used in the pharmaceutical trade, and iron salts and oxides used in the textile industry and as pigments. Among these, ferric nitrate is used in silk dyeing and weighting and for coloring buff on cotton. Ferric chloride is used as a mordant. Ferrous sulphate (copperas) is used as a mordant and in making ink, Prussian blue and red oxide. Ferrous acetate is used as a mordant in leather dyeing and calico printing. Ferric hydroxide, called iron buff or Nankin yellow, is used as a dye. The pigments made from oxide are based on the use of pure ferric oxide, F_2O_3, and include red ochre, rouge, venetian red. The iron is also used in the manufacture of Van Dyke brown and tannate of iron black.

Characteristics of Svea Metal

Brinnel hardness at 500 kg.	86
Coefficient of expansion, linear per deg. C.	12×10^{-6}
Compressibility per unit volume per kg/cm²	60×10^{-6}
Conductivity. Thermal cal. per cm. per cm² per sec. per deg. at 10 deg. C.	.161
Density, at 20 deg. C.	7.86
Elongation	40%
Melting point	1535 deg. C.
Reduction of area	65%
Specific gravity	7.86
Specific heat, cal. per gm. per deg. C. at 0 deg. C.	.1150
Tensile strength, lb. per sq. in.	44000
Yield point, lb. per sq. in.	23000

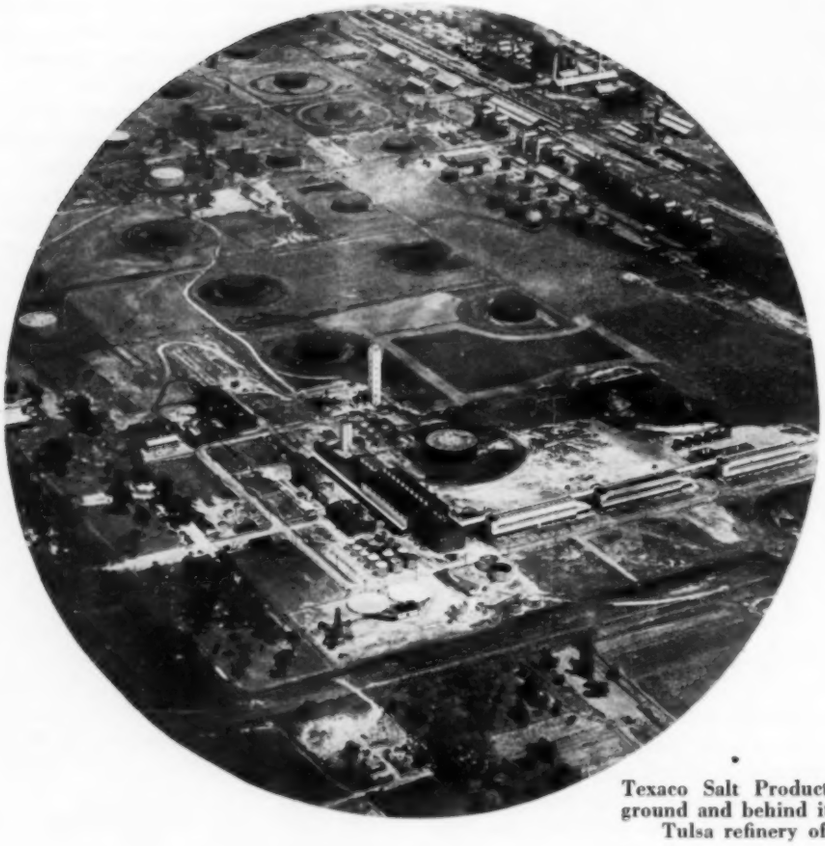
The utility of the metal as a material of construction for process equipment rests upon its unique physical properties and its resistance to corrosion as compared with other ferrous metals. It has a high melting point, 1,535 deg. C. which makes it suitable for heating equipment except that exposed to direct flame and uncooled, as in roasting furnaces. It also has the ability to withstand alternate heating and cooling almost indefinitely without fatigue, change in structure, or distortion.

The metal, being the softest form of iron ever produced, has been found useful for parts of equipment such as gaskets, shims and spacers, where it is necessary to have a constant thickness over long periods of use. For instance, it may be used for boiler heads, and similar applications where the repeated heating to which it is subjected does not change its thickness.

The resistance of the material to corrosion is improved when it is thoroughly cleaned and then hydrogen annealed at 800 to 1,000 deg. C. In this form it offers a much higher resistance than other irons to all ordinary atmospheric corrosion, provided it does not come into direct contact with acid, salt, or other corrosives.

Another useful characteristic is that the metal will not form an amalgam with mercury under ordinary conditions. This makes it suitable for equipment used in the handling of mercury, as it is naturally much less fragile than much of the material that has been used for this purpose.

MID-CONTINENT BRINE



Texaco Salt Products Co. in the foreground and behind it a part of the West Tulsa refinery of The Texas Co.

WHEN Chem. & Met., in the Spring of 1932, completed its editorial survey of recent chemical engineering developments in the Southwest, we were disappointed in not being permitted to describe the $2,000,000 project of The Texas Co. for utilizing the waste heat from its West Tulsa refinery. Our visit through the plant was made with the understanding that nothing would be published until officially authorized by the management in New York. That information has just been released through the Texaco Star. Subsequent articles in that publication will deal with the geological formations in the vicinity and the use of the products manufactured by the Texaco Salt Products Co. EDITOR.

SALT WATER is commonly used in the condensers of oil refineries along the seaboard—for no other reason than that the ocean provides a cheaper and unlimited supply of this cold but also corrosive cooling medium. In the middle of the continent, a good many miles from the sea, one would naturally expect the oil refiner to use fresh water, especially if it happened to be available in abundance. Yet in 1931 at its West Tulsa, Okla. refinery, The Texas Co. drilled a 3,500-ft. well for the express purpose of obtaining salt water to be used in its condensers. But another and perhaps the primary purpose was to let the waste heat from the oil refinery concentrate this same salt water and thereby release commercial quantities of salt, calcium chloride, epsom salt and bromine.

Thus came into operation one of the outstanding industrial developments of the depression period. This striking demonstration of the inter-dependence of two such apparently unrelated industries stands as a record of achievement in chemical engineering.

Several years ago, The Texas Co. acquired certain patents for the use of brine (especially treated to prevent corrosion) as a cooling medium and for the spraying of this brine in a heated state to cause the evaporation of the water in the brine. Texaco Salt Products Co. was organized as a subsidiary and construction started early in 1931. Salt sales began in September of that year, followed shortly by commercial production of calcium chloride, bromine, and epsom salt. The latter plants were just getting into operation at the time of the writer's visit in the Spring of 1932.

The brine is pumped from the well by an air lift and

YIELDS SALT BROMINE CALCIUM CHLORIDE AND EPSOM SALT

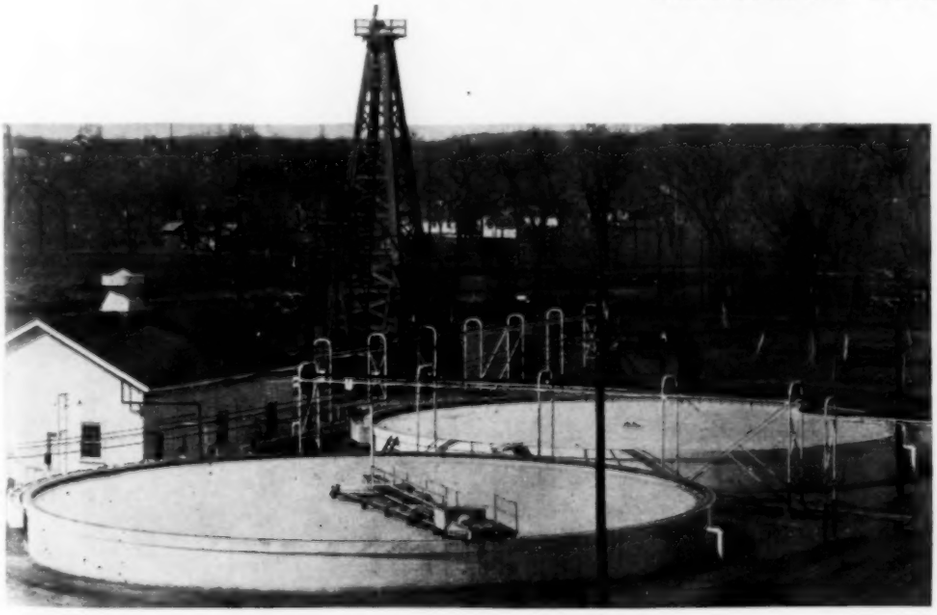
EDITORIAL STAFF REPORT

first treated with lime to precipitate the magnesium in the form of the hydroxide, which is separated from the brine in the Dorr equipment shown in an accompanying illustration. The brine is sent to the refinery a half mile away where it performs its cooling function and in so doing acquires the heat for its evaporation. The heated brine is sprayed over huge spray ponds or towers which are pictured on the following page. The rate of evaporation is largely controlled by adjusting the openings on either side of the tower since it is through these that the air circulates and the water passes into the air in the form of vapor.

Describing this phase of the process in the current issue of the *Texaco Star*, Rollin L. Drake, vice-president and general manager of Texaco Salt Products Co., writes as follows: "The circulation of the brine to and from the refinery is continuous, with a certain amount of new brine being added at intervals. As the brine becomes heavier, because of the loss of water, the salt heretofore held in solution in the brine drops out, accumulating in the concrete, steel-lined pond beneath the spraying nozzles. Here it is gathered by drag-chain conveyors and carried by bucket elevators and rubber belts to the washer house. Washing, filtering, and drying take place here to make the salt a pure and snow-white product.

"If the salt is to be held for bulk shipment, it passes by belt conveyor to the bulk storage room, where it accumulates in a huge pile of several thousand tons. If it is to be packaged, bagged, or blocked, it undergoes another thorough drying in a steel rotary kiln and is then screened to separate it into the various grades."

Returning now to the salt spray pond, we pick up the bittern which is the raw material from which the bromine



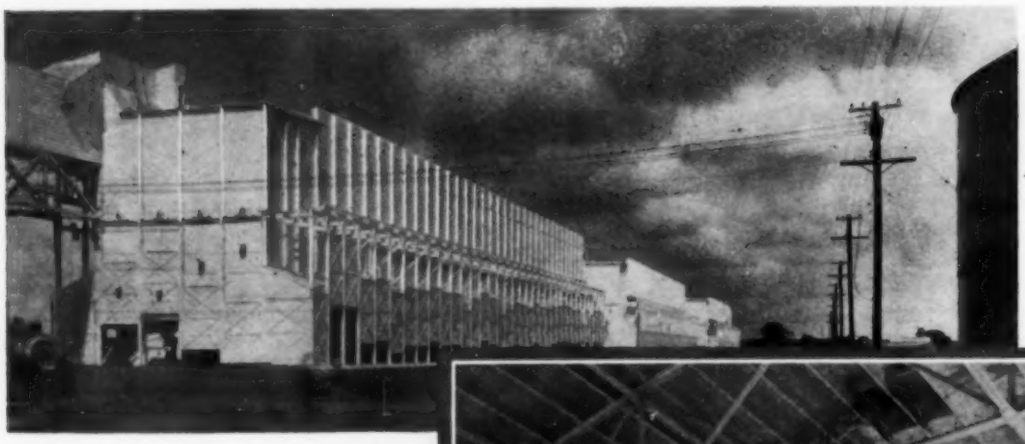
Brine from the well is treated with lime to produce magnesium hydroxide—the first step in the manufacture of epsom salt

and calcium chloride are obtained. It is pumped first to the bromine tower, which is 170 ft. high and by far the tallest structure in the plant. In it are located seven Pfaudler glass-lined steel tanks connected with Pyrex glass pipe. In these stills the bittern is treated with chlorine and steamed to liberate the bromine which is distilled off and condensed into the well-known heavy, brown liquid that finds its principal market in the form of ethylene dibromide for use in a well-known brand of anti-knock motor fuel.

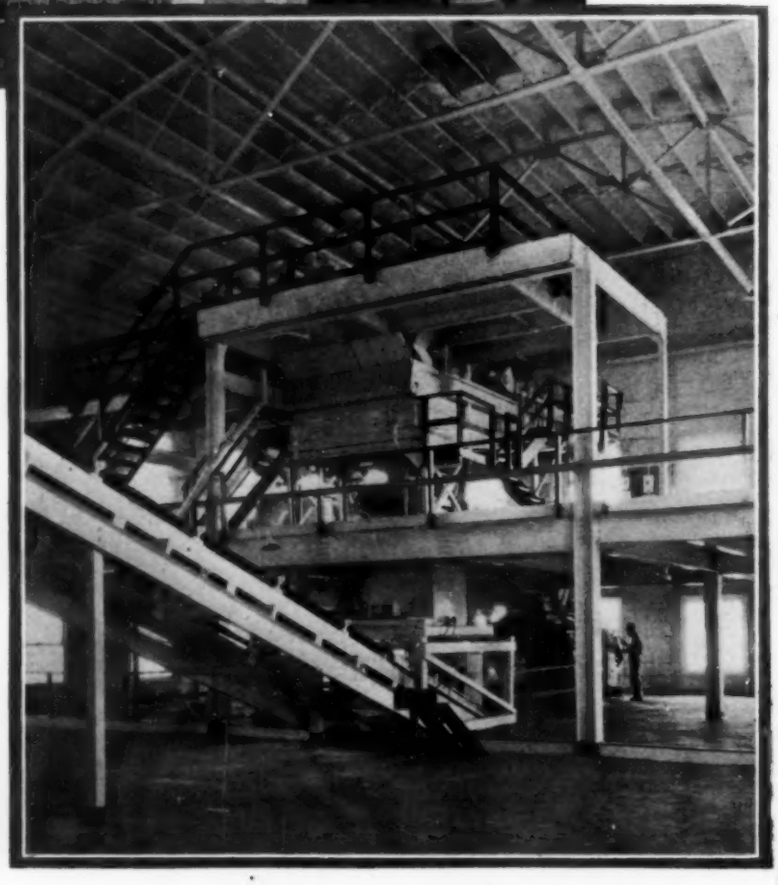
After the bromine has been extracted, the bittern goes to the kettles in the calcium chloride plant where it is concentrated, run over chilling rolls and thus obtained in flake form, or it may be run directly into drums where it quickly sets to solid calcium chloride. The flakes are widely used as a dust preventative in highway construction and coal treatment, while the solid calcium chloride is sold largely for use in refrigeration.

The magnesium hydroxide, precipitated from the brine in the first stage of the process, is filtered in a continuous filter, washed free of soluble salts and then treated with sulphuric acid to form the needle-like crystals of epsom salt. Washed and dried, these crystals are ready for packaging, the product leaving the plant in paper-lined barrels, kegs, paper-lined bags and canisters. The pure product is repacked by drug houses for the retail trade. Technical or commercial epsom salt finds its chief use in the textile and leather industries, particularly in the manufacture of viscose rayon.

For the privilege of reproducing the official photographs of The Texas Co. *Chem. & Met.* is indebted to Philip C. Humphrey, editor of company publications.



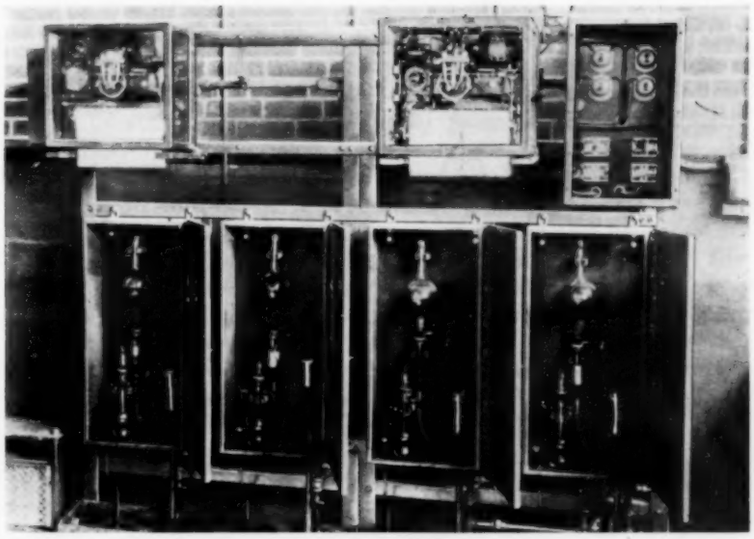
In these spray towers the heated brine returning from the refinery is sprayed to evaporate the water. The salt is gathered from steel lined ponds below



In this washer building the salt is washed, filtered and dried. It passes up on the belt conveyor at the left to storage or to the packing rooms

Measurement and Control of Hydrogen Ion Concentration

By GEORGE A. PERLEY
Leeds & Northrup Co.
Philadelphia, Pa.



Four quinhydrone units recording pH in a water-treatment plant

CONSIDERING the vast accumulation of data pertaining to the theory and use of the many methods for measuring the acidity and alkalinity of solutions, it obviously is impossible to present a thorough discussion of the entire subject in a single paper. No attempt can be made here to discuss the growing importance of acidity and alkalinity measurements in industry, nor to describe actual installations of acidity and alkalinity measuring and controlling apparatus. Furthermore, it is assumed that the distinction between hydrogen ion concentration (pH) and total acidity and alkalinity is well understood and needs no clarification here.

The chief purpose of this paper is to present the advantageous features of modern methods of pH measurement and control and to show which method is better adapted to the conditions than are the other possible means of measurement. Should the chemical engineer become dismayed because he has to consider four potentiometric methods, including the hydrogen electrode, the quinhydrone electrode, the antimony electrode and the glass electrode, as well as a variety of colorimetric measuring methods, he should stop to consider the art of industrial temperature measurement in which are many measuring methods and many types of equipment for the various applications. A similar situation exists in the field of pH measurements, but here the art has not developed to the same extent as in temperature measurement and the choice of a proper method and equipment is not so well defined.

Much of the laboratory data relative to pH phenomena has been obtained by the use of "buffer" solutions. The presence of acetates or phosphates or citrates or borates assures "buffer action." Measurements of pH in solutions which are capable of maintaining a nearly constant pH when an acid or base is added, or when diluted with water, are comparatively simple. It is important to bear in mind that buffer action depends upon the nature and concentration of the constituents, upon the type of acid or alkali added and upon the pH region of the measurement.

Many industrial problems involve only slightly buffered solutions. A trace of carbon dioxide from the atmosphere, alkali salts from the containers, hydrolysis in the solution or impurities may exert pronounced effects upon the pH of a solution which is only slightly buffered. The presence of adsorbed gases, oxides, etc., in the pH electrode is a source of great concern and renders measurements in unbuffered or only slightly buffered solutions considerably inaccurate. Even chemical indicators in solution function as either weak acids or weak bases and exert such a distinct influence on poorly buffered solutions that the measurement is only an approximation.

Before he attempts to discover the most suitable method of pH control, the chemical engineer who believes that a given process functions best and most economically within a certain pH range, should first utilize intermittent methods of measurement upon test samples to establish the facts. For example: (*a*) Is the solution highly or sparingly buffered? (*b*) What is the solute composition and what variation in this composition will occur? (*c*) What is the temperature range of the process? (*d*) What is the pH range? (*e*) How rapidly may the extreme changes of pH occur? (*f*) Are strong oxidizing agents present? (*g*) Will the process yield a colored solution, a colloidal suspension,

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Abstracted from a paper presented by the author, under the title of "The Measurement and Control of Hydrogen Ion Concentration in Industrial Plants," before the Chicago meeting of the American Institute of Chemical Engineers, June 16, 1933. For a much more extensive discussion of the peculiarities of the several methods, particularly colorimetric methods and the hydrogen and quinhydrone electrodes, and for an extensive reference list, the reader should refer to the original Institute paper, when published in the "Transactions."

turbidity or a coarse mechanical suspension? (*h*) What variation in pH may be tolerated? (*i*) Are any dissolved gases present?

The answer to (*a*), (*d*), (*e*) and (*h*) should be obtained by the use of a precise intermittent method of pH measurement. A potentiometric method is the most desirable for this type of preliminary precision measurement. These considerations provide a basis for an intelligent decision as to the correct system to be used where careful pH process control is essential.

A rather extensive group of colorimetric indicators is now available which exhibit different colors and shades of color in solutions of different hydrogen ion concentration over the range of 0.2 to 13.6 pH. The colorimetric methods may be used where the solutions are moderately well buffered; where a limit of error of 0.2 pH is adequate; where abrupt pH changes are not likely to occur in the process solutions; where the nature and concentration of the dissolved salts permits making the necessary salt error correction; where deeply colored solutions, suspensions, colloidal and protein bodies are not present.

Potentiometric Methods

The chemical engineer who desires to control the pH of a given process in an efficient manner must decide between the use of an intermittent method of measurement, as obtained on test samples, an automatic recording method secured in a continuous flowing solution, or an automatic control equipment.

Both colorimetric and potentiometric methods are available for the intermittent system of measurement. If the solutions are only slightly buffered, if there is a high and variable solute concentration, if colloidal suspensions are present, if highly colored solutions are involved, if a heavy suspended material is encountered, or if a process control of 0.1 pH is required, a potentiometric pH method will generally be far superior to the colorimetric system of measurement.

Abrupt variations in pH occur in many types of chemical processes. If the variations in pH are beyond the limits of toleration, it is useless to attempt to make the measurements by means of an intermittent type of indicating equipment. Provision for continuous recording must be made. The potentiometric method lends itself admirably to such measurements.

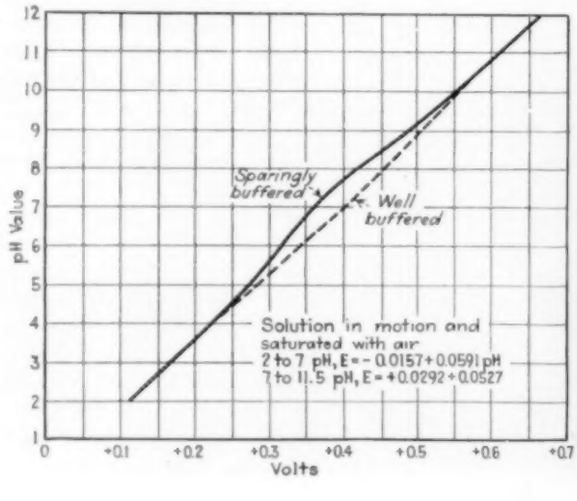
The manual control of the pH of a process may be carried out with a fair degree of efficiency where only an occasional adjustment is required. Whenever a large number of changes must be made, or where there may be some question as to the extent of adjustment, it is desirable to utilize automatic control. The nature of the variation and the tolerance of the pH, as well as the cost of the control unit, defines in part the choice as to whether automatic control is essential to any process.

Hydrogen and Quinhydrone Electrodes

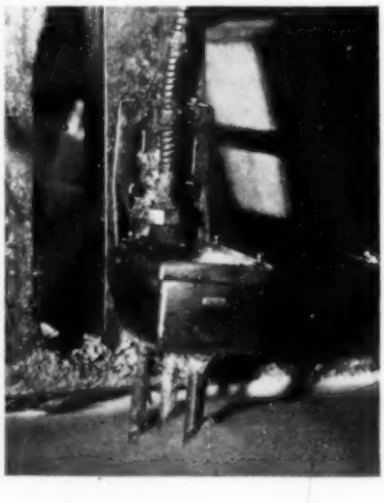
The hydrogen gas electrode is essentially limited to intermittent indicating measurements. This electrode requires a source of hydrogen which is free from oxygen and a catalytically active platinum, palladium or iridium surface.

A limit of error not exceeding 0.01 pH over the range of 0 to 14 pH may be obtained with buffered solutions which do not contain strong oxidizing agents or any dissolved oxygen or air. This hydrogen electrode is extremely useful in checking standard buffer solutions which may be utilized in the calibration of colorimetric standards or of the various types of pH electrodes. The hydrogen gas electrode cannot be used in solutions where the pH is due in part to the presence of dissolved gases such as oxygen, carbon dioxide, sulphur dioxide, ammonia, etc., or where foams are encountered. The presence of metals more acidic than hydrogen in the "electromotive series," of sulphides, of sulphites, calomel, arsenic compounds, etc., are sources of possible errors when a hydrogen gas electrode is utilized. At the present time no practical hydrogen gas electrode has been developed for continuous measurements.

The quinhydrone electrode does not require any gas or catalytic surface. The addition of a small, but definite, quantity of quinhydrone to the solution and the use of a carefully cleaned, smooth platinum or gold electrode permits a simple and rapid pH measurement. This electrode has a limit of error not exceeding 0.02 pH, over the range of 1 pH to 8.6 pH, in solutions of mild oxidizing intensity, in nickel, copper, aluminum and other metallic salt solutions, solutions of milk, beer, blood, medicinals, soil solutions, plant juices, etc. The quinhydrone electrode is of particular value for measurements in turbid or colored solutions, or in solutions con-


pH Value
Volts
Sparingly buffered
Well buffered
Solution in motion and saturated with air
2 to 7 pH, E = - 0.0157 + 0.0591 pH
7 to 11.5 pH, E = + 0.0292 + 0.0527

Left: Calibration curve for an antimony-saturated calomel electrode at 25 deg. C. showing effect of buffered and unbuffered solutions



Right: Antimony electrode installation in a paper mill beater

Glass electrode used for control

taining dissolved oxygen, air, carbon dioxide, etc. This electrode is particularly well adapted to the continuous recording and controlling of the pH of industrial solutions of the type and over the range discussed in the above. The decomposition and oxidation of the quinhydrone at alkalinities above 8.6 pH is such as to limit the use of this electrode above this pH. The use of the quinhydrone electrode in very sparingly buffered solutions between 5 pH and 8.5 pH involves errors varying between 0.1 to 1 pH. The presence of high concentrations of ferric salts, hydrogen sulphide, chromates, permanganates, peroxides, hypochlorites, sulphites and certain manganese sales gives errors which vary between 0.3 and 2 pH and accordingly the use of this electrode in such solutions is not recommended.

Antimony Electrode

A pH electrode which did not require gas or a catalytic surface would have advantages over the hydrogen gas electrode; also an electrode which did not require the continuous addition of a secondary substance and which was available for the alkaline range would be preferable to the quinhydrone electrode in many industrial processes. Various metal/metal oxide electrodes have been discussed in the literature, yet none, with the exception of the antimony electrode first employed in 1924 by Uhl and Kestranek, has developed into a satisfactory industrial type of pH electrode for use over a wide range of pH.

The potential of a metal/metal oxide electrode depends upon the temperature, the hydrogen ion concentration, the solubility product of the oxide or hydroxide, the ionization constant of water and the electromotive activity of the metal. The fixing of four of the variables to secure a constant influence of all except the hydrogen ion concentration is the real problem in the development of a satisfactory metal/metal oxide electrode. The best metal would be less basic than hydrogen in the "electromotive series" and yet it should be readily oxidizable. It should not be attacked by acid or alkaline solutions. It should have a sparingly soluble oxide to supply metal ions, and this oxide should not form a series of hydrates. The requirements narrow the list of available metals to antimony and silicon.

A study of the construction and properties of the antimony electrode, particularly as applied to industrial pH measurements, has been made. An important secondary equilibrium is set up at an antimony interface when submerged in an aqueous solution in contact with air. This is:

$$4Sb + 3O_2 + 6H_2O \rightleftharpoons 4Sb(OH)_3 \qquad (1)$$

and hence the existence of antimony ions at the metal surface is assured if dissolved oxygen has been present.

The antimony electrode has not been suitable for precise measurements with solutions in contact with air, although approximate pH measurements were easy to obtain with an electrode which had been calibrated under particular conditions of use. Standardization of the purity of metal, a proper method of mounting the metal and a definition of the conditions of use make it possible to reduce the limit of error to 0.2 pH when using the antimony electrode in the range of 2.0 to 12.0 pH and in continuous operation.

A few facts relative to the peculiarities of the antimony electrode are essential to maximum usefulness. Although the precision is not as high as in the case of the hydrogen or quinhydrone electrodes, it is sufficient for the control of many industrial processes. An interesting feature of the antimony electrode is that the calibration in a solution saturated with air is different from that in a solution saturated with oxygen or nitrogen. This arises from the fact that the antimony oxidation reaction involves an equilibrium which depends upon the partial pressure of oxygen. In the acid range any condition, such as a nitrogen atmosphere, consumption of oxygen by agents in the solution, hot solutions, etc., which tends to cause depletion of oxygen below a certain partial pressure, will give varying pH values due to a changing antimony ion concentration. Furthermore, the calibration is different, when there is movement of a solution in contact with air, than in the case of a stationary solution. In the absence of dissolved oxygen, in the acid range, the equilibrium conditions will be shifted as fresh solution comes in contact with the metal interface and a variable saturation of antimony hydroxide results at the metal surface. In an atmosphere of oxygen, the use of a properly mounted antimony electrode, even in the absence of antimony trioxide, has a limit of error of 0.1 pH over the range of 2 to 7 pH and with temperatures of 5 deg. C. to 40 deg. C.

In the alkaline range various effects tend to change the slope of the E/pH curve. In the absence of oxygen the antimony surfaces must be oxidized prior to use and the solution saturated with antimony hydroxide. Under these conditions, a pH measurement may be made over the range of 7 to 12.0 pH with a limit of error of 0.1 pH.

A further factor is that the calibration of an antimony electrode in a buffer solution in contact with air is different from that in a non-buffer solution over the range of 4.5 pH to 10.0 pH, as shown on page 418.

The antimony electrode is not applicable to solutions which are strongly reducing or oxidizing. The presence of calomel dissolved in potassium chloride produces a surface change on the antimony which results in large errors. In the alkaline range high concentrations of sodium salts tend to produce sparingly soluble antimonates with a resultant error. The nature and concentration of the dissolved salts will exert some influence upon the solubility of the antimony hydroxide but this influence in many control processes is relatively constant.

The antimony electrode has a distinct advantage for the continuous recording or control of pH in that the addition of no reagent, solid or gas is required for the measurement. The life of an electrode which is in continuous use should be in excess of six months. The electrode can be installed directly in a tank or kettle without fear of breakage. The response to pH changes is immediate. It may be used in the measurement of heavy sludges, pastes, etc. Installations in the beaters of paper mills have given excellent results in spite of the heavy stock encountered.

The use of the antimony electrode for continuous control of pH to within 0.2 pH is inviting in the liming of industrial waters, in sugar refinery control, in wool scouring and in many other industrial applications. The antimony electrode is by far the most rugged pH electrode available and the individual electrodes are interchangeable within 0.1 pH.

Glass Electrode

Although Creamer in 1906 showed that a thin glass membrane produced potentials which were a function of the hydrogen ion concentration, the real value of this electrode was not recognized until in 1922 the work of Hughes, followed by that of Kerridge and MacInnes and Dole showed the potentiality of this measuring device.

The theory of the action of the glass electrode is at present in an uncertain status although many attempts have been made to present a sound explanation. A crude picture of what happens may be made without explaining how this occurs. A thin glass wall of a certain composition and containing a small amount of water serves as a conducting medium due to the presence of hydrogen ions which can move in and out of the surface of the glass. If the glass composition does not show great changes, the hydrogen ion activity should remain constant. If two solutions having a difference in hydrogen ion concentration are separated by such a glass wall, any difference in potential between them will tend to establish an equilibrium by electrolytic conduction through the glass. The glass membrane behaves like a hydrogen electrode over a certain pH range.

The composition of the glass is rather critical if it is desired to measure hydrogen ion concentration. Glass of 72 per cent SiO_2, 22 per cent Na_2O and 6 per cent CaO is extensively used. Quartz and paraffin membranes will also act as hydrogen electrodes. A membrane with a resistance below 7 megohms is desirable if the asymmetry potential, sensitivity and shielding difficulties are to be held within reasonable limits.

Measurement of the potential difference set up on the two sides of the glass membrane necessitates the use of an internal and external electrode terminal. These electrodes must not be influenced by any variations of pH within the test solution. A quinhydrone reference electrode in 1 pH hydrochloric acid is very easy to prepare, is reproducible within less than 1 millivolt and is stable for at least a period of a month. A suitable quinhydrone electrode unit which is filled with 1 pH hydrochloric acid may be used on the inside of the glass electrode and the whole unit closed by a stopper to prevent change of the acid. Errors due to junction potentials are eliminated. The external electrode which makes contact with the test solution through a proper bridge, and is independent of pH changes within the test solution, should be a saturated calomel electrode.

Bulb type glass electrodes may be made which are relatively robust and can be used for many types of industrial measurements. A 1-in. bulb is blown on the end of 18-mm. glass tubing. Approximately 15 cc. of a 1-pH hydrochloric acid is used inside the bulb and the quinhydrone reference electrode is located in this acid. The resistance of these electrodes varies from 2 to 6 megohms. With a Leeds & Northrup 2500-b type of galvanometer with a sensitivity of 5×10^{-4} microamperes per mm. (at one meter) it is comparatively simple to duplicate readings within 0.02 pH and no painstaking precautions in shielding are required. This equipment is simple and is easy to manipulate. However, it is applicable only to intermittent indicating measurements since the galvanometer sensitivity in a recording potentiometer is not adequate for glass electrode systems. Thermionic equipment can be used to good advantage when a recording measurement is to be made by means of the glass electrode.

The advantages of the glass electrode over the other types of pH electrodes are that it gives an accurate measure of pH in the presence of oxidizing and reducing potentials, ferric oxide sols, tanning liquor extracts and similar solutions where all other types of electrodes have given erroneous results. It thus widens the field of application of industrial pH measurement and control. An industrial type of glass electrode is now available which is reproducible to within 0.05 pH when checked in a standard buffer solution, and shows remarkable stability of the electrode over many days of continuous operation. Sparingly buffered solutions may be measured more accurately with the glass electrode than with the other pH electrodes.

There are certain limitations in the use of this interesting pH electrode, particularly in the alkaline range. The glass electrode gives an emf./pH relationship which is linear over the range of 1 to 9.6 pH when calibrated with buffer solutions in which the sodium ion concentration does not exceed 0.1 molar. A calibration curve may be obtained for the range of 9.6 pH to 12.5 pH which is reproducible within 0.10 pH, provided approximately the same ion concentration is maintained in all measurements. Potassium and calcium ions are less upsetting in their effect. It is possible to secure special calibration curves for the various kinds and concentrations of salts which may be present in the alkaline range and thereby obtain a limit of error of only 0.15 pH.

The glass electrode is not rugged and must be handled with care, but the electrode assembly may be mounted in a flow channel so that industrial control can be carried out without fear of breakage troubles. It approaches a universal industrial pH electrode more closely than any other pH measuring device.

Where the Rayon Industry Stands Today

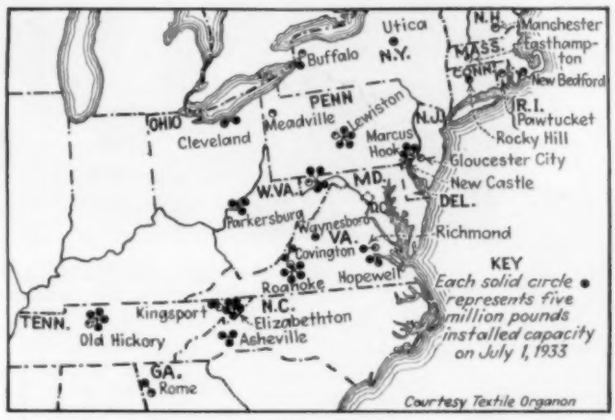
THROUGH the courtesy of the *Textile Organon*, published by the Tubize Chatillon Corp., we are able to reproduce below a tabulation of the present and contemplated state of the American rayon industry, taken from reports made by 17 of the 18 producers. The figures are based on installed production capacity as of July 1, 1933, together with reported plant expansions, both actual and in prospect.

On July 1 it is evident that there was a capacity of 180,700,000 lb. of viscose rayon, 35,500,000 lb. of acetate, 8,900,000 lb. of cuprammonium, and 8,300,000 lb. of nitrocellulose, bringing the total for all kinds to 233,400,000 lb. of yarn per year. These figures, of course, are based on installed capacity. Operating capacity, according to the *Organon*, is from 10 to 15 per cent less due to unbalanced plant, denier change-over, machine repairs and other factors. The accompanying short tabulation shows the industry's breakdown by processes.

U. S. Rayon Installed Capacity by Processes

	July 1, 1931*	July 1, 1933	After New Installation
Viscose	82.2%	77.5%	78.2%
Acetate	11.1	15.2	14.8
Cuprammonium	2.6	3.8	3.8
Nitrocellulose	4.1	3.5	3.2
Total	100%	100%	100%

**Textile Organon*, August, 1931.



American Rayon Installed Capacity by Plant and Process

As of July 1, 1933 (Plus Reported Expansion)

(Units Are Millions of Pounds Per Year)

(Courtesy *Textile Organon*, Tubize Chatillon Corp.)

Company and Plant Location	Total Company	Total Plant	Viscose Yarn	Acetate Yarn	Cupra Yarn	Nitro Yarn	New† Capacity	Future Capacity
The Viscose Co.	77.0	....	....	....	....	....	....	87.0
Lewiston, Pa.	....	22.0	22.0	....	....	....	....	....
Marcus Hook, Pa.	....	15.0	15.0	....	....	....	....	....
Meadville, Pa.	....	3.0	....	3.0	....	....	2.0 *a*	....
Parkersburg, W. Va.	....	15.0	15.0	....	....	....	8.0 *v*	....
Roanoke, Va.	....	22.0	22.0	....	....	....	....	....
Du Pont Rayon Co.	37.2	....	....	....	....	....	....	37.2
Buffalo, N. Y.	....	6.4	6.4	....	....	....	....	....
Old Hickory, Tenn.	....	21.3	21.3	....	....	....	....	....
Richmond, Va.	....	6.5	6.5	....	....	....	....	....
Waynesboro, Va.	....	3.0	....	3.0	....	....	....	....
Celanese Corp. of America*	22.0	....	....	....	....	....	....	22.0
Amcelle, Md.	....	22.0	....	22.0	....	....	....	....
American Glanzstoff Corp.	17.3	....	....	....	....	....	....	20.0
Elizabethton, Tenn.	....	17.3	17.3	....	....	....	2.7 *v*	....
Industrial Rayon Corp.	16.7	....	....	....	....	....	....	16.7
Cleveland, Ohio	....	7.0	7.0	....	....	....	....	....
Covington, Va.	....	9.7	9.7	....	....	....	....	....
Tubize Chatillon Corp.	16.3	....	....	....	....	....	....	25.3
Hopewell, Va.	....	8.3	....	....	....	8.3	....	....
Rome, Ga.	....	8.0	6.0	2.0	....	....	9.0 *v*	....
American Enka Corp.	15.0	....	....	....	....	....	....	17.0
Asheville, N. C.	....	15.0	15.0	....	....	....	2.0 *v*	....
American Bemberg Corp.	7.9	....	....	....	....	....	....	10.0
Elizabethton, Tenn.	....	7.9	....	....	7.9	....	2.1 *c*	....
Tennessee Eastman Corp.	5.5	....	....	....	....	....	....	5.5
Kingsport, Tenn.	....	5.5	....	5.5	....	....	....	....
Skenandoa Rayon Corp.	3.5	....	....	....	....	....	....	3.8
Utica, N. Y.	....	3.5	3.5	....	....	....	0.3 *v*	....
New Bedford Rayon Co.	3.0	....	....	....	....	....	....	3.0
New Bedford, Mass.	....	3.0	3.0	....	....	....	....	....
The Belamose Corp.	2.8	....	....	....	....	....	....	2.8
Rocky Hill, Conn.	....	2.8	2.8	....	....	....	....	....
Woonsocket Rayon Co.	2.2	....	....	....	....	....	....	2.2
Pawtucket, R. I.	....	2.2	2.2	....	....	....	....	....
Delaware Rayon Co.	2.0	....	....	....	....	....	....	2.0
New Castle, Dela.	....	2.0	2.0	....	....	....	....	....
Hampton Co.	1.5	....	....	....	....	....	....	1.5
Easthampton, Mass.	....	1.5	1.5	....	....	....	....	....
Amoskeag Manufacturing Co.	1.3	....	....	....	....	....	....	1.3
Manchester, N. H.	....	1.3	1.3	....	....	....	....	....
Acme Rayon Corp.	1.2	....	....	....	....	....	....	1.2
Cleveland, Ohio	....	1.2	1.2	....	....	....	....	....
Furness Corp.	1.0	....	....	....	1.0	....	....	1.0
Gloucester City, N. J.	....	1.0	....	....	....	....	....	....
Total Installed Capacity	233.4	233.4	180.7	35 5	8.9	8.3	26.1	259.5
Operating Capacity (at 90%)	210.0	210.0	162.7	32.0	8.0	7.5	23.5	233.5

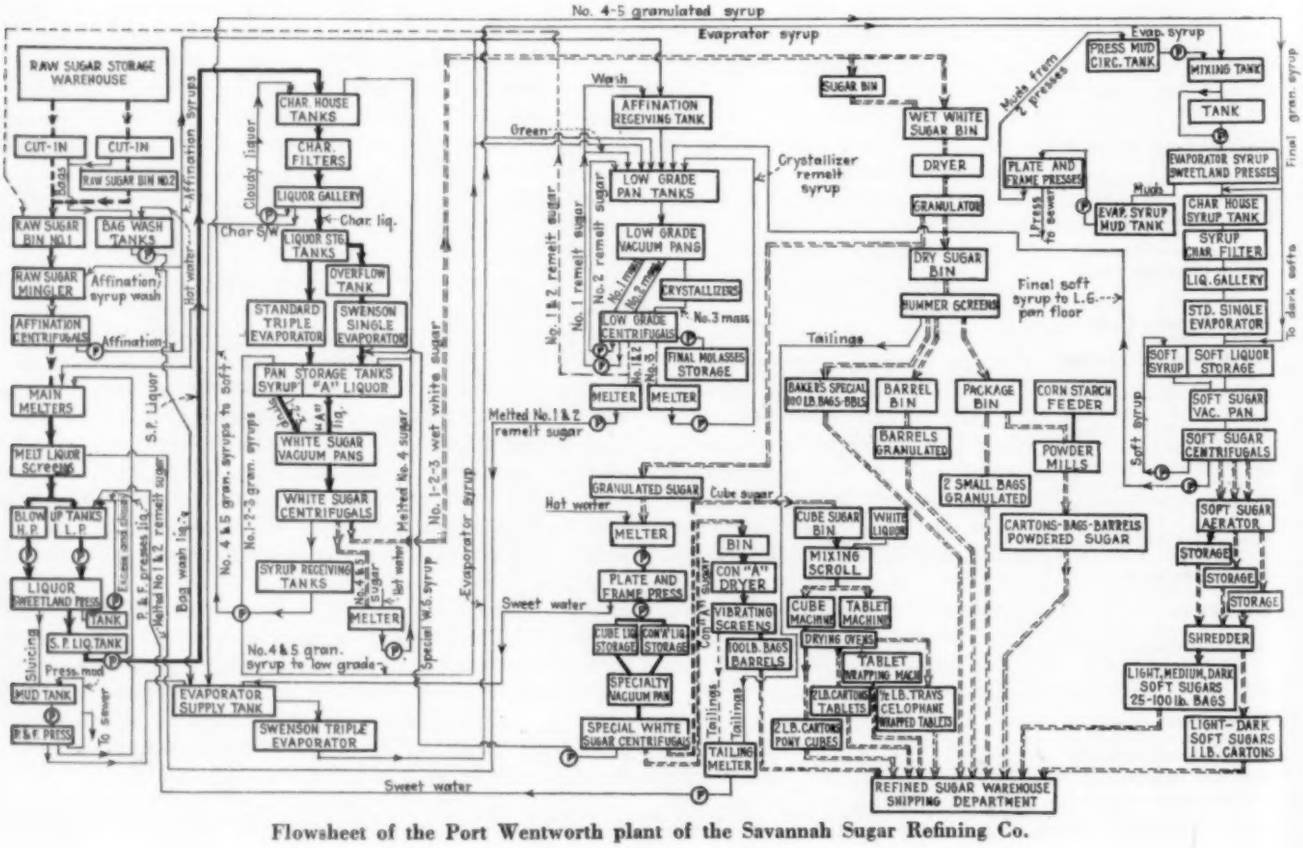
*Estimated.

†*a*, acetate; *c*, cuprammonium; *v*, viscose. Tubize to install 3 million lb. viscose by December, 1933, and 6 million lb. in 1934; Skenandoa's 0.3 million lb. increase under consideration; Bemberg's and Glanzstoff's increases to be started in September, 1933.

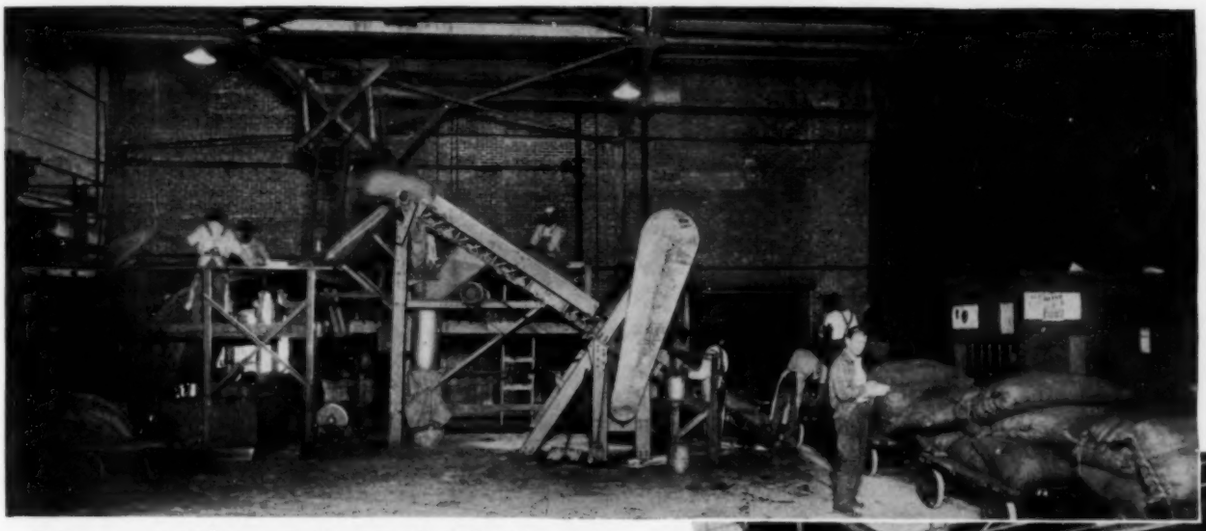
After sampling, the sugar is weighed by Federal employees on their own scales and reweighed on the purchaser's scales. It is then stored in piles to await the start of the refining process

REFINING CANE SUGAR

Port Wentworth plant of the Savannah Sugar Refining Co. has a capacity of 1,250 tons of raw sugar a day. It is one of eight refineries in the South that buy the raw product from plantations in Florida, Louisiana, Porto Rico and Cuba and convert it into granulated sugar

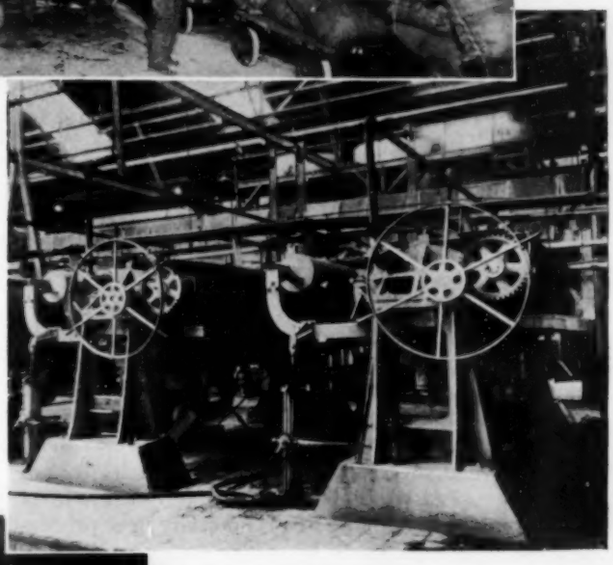


Flowsheet of the Port Wentworth plant of the Savannah Sugar Refining Co.

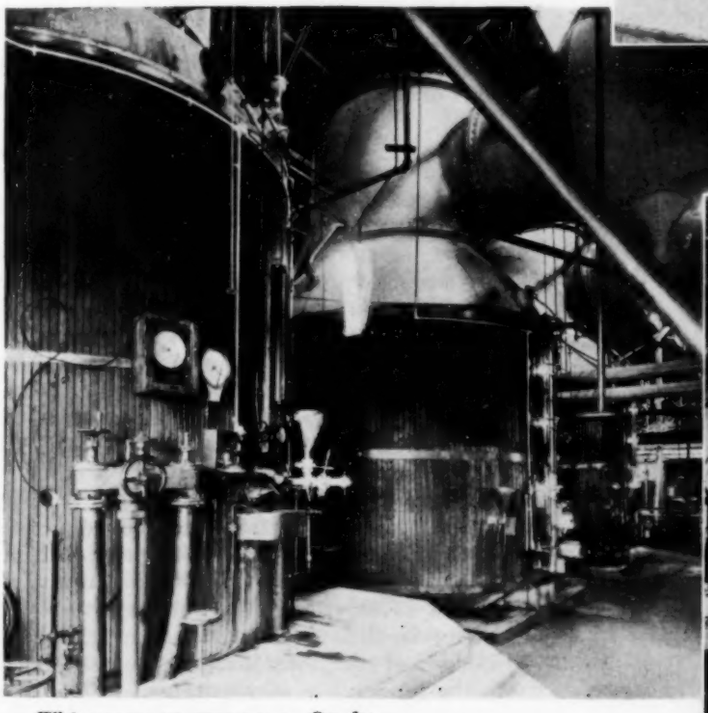


Bags are opened by two workmen on the left and emptied into a pit in the floor, from which a screw conveyor starts the raw sugar on its way

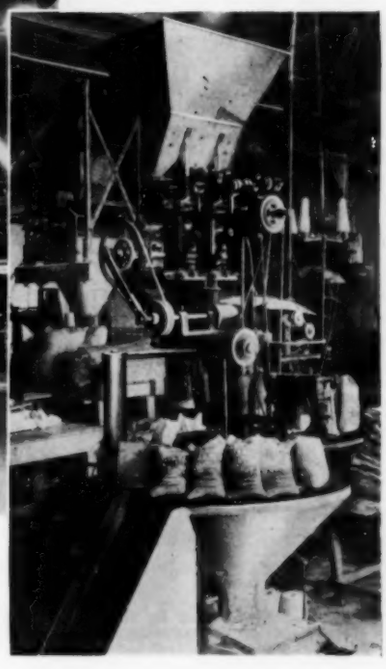
IN THE SOUTH



Sugar liquor is forced through Sweetland filter presses. The clarified liquor then flows to tanks which act as reservoirs to supply liquor to the char filters



White sugar vacuum pans. On the left is the pan used for special sugars



Dixie Crystals are packed into many types of package by automatic machinery

From Laboratory to Plant Via "The Half-Way House"

By DAVID E. PIERCE

Charles Lennig & Co.
Philadelphia, Pa.

HALF-WAY between the test tube and full-scale operation of every budding chemical project comes the Half-Way House—the semi-works, in which is determined the success or failure of the great majority of new processes. Important as it is, it is strange that so little has been written about it; what happens between the beaker and the tank car rarely comes to light. It might seem, therefore, that there is little to be said, but 15 years of more or less close contact with this phase of chemical engineering has led the author to the conclusion that many semi-works problems can profitably be discussed—problems of equipment, of organization, of operating methods, of economics, and so on. Far too little has been recorded on this important stopping point in the road that leads to commercial success.

The best semi-works is one that is designed to meet four general types of demand: (*a*) To study new processes or new types of equipment to secure data for plant design; (*b*) To study proposed variations in old processes to improve yield, quality, design of equipment, etc; (*c*) To make sample batches of new products for introduction to the trade; and (*d*) To manufacture for sale new, or special products for which the demand is not large enough to justify plant operation.

Semi-Works Organization

Responsibility for the design and arrangement of the semi-works plant should rest upon an experienced chemical engineer. He must have not only the proper training to enable him to appreciate the chemical and engineering problems involved; he must be able to evaluate the economic factors; and he must be able to secure cooperation between the laboratory, the engineering design staff and the operators who actually handle the equipment.

Under the supervising chemical engineer, some companies place a staff of technical men to direct the work on individual problems which come from the research laboratories. This policy is one to which the author takes exception. The direct supervision of experimental runs should be up to the men who have done the laboratory work and who, therefore, are thoroughly familiar with the entire history of the development.

Aside from this direct supervision of runs on new processes, there are always engineering problems to be studied in detail. For this work, most organizations require one or more junior engineers. According to a survey by A. H. White (Trans. A.I.Ch.E., **27**, 321) nearly 30 per cent of the graduates who went into actual engineering work were engaged in semi-plant development during the first five years after graduation.

In addition to the engineering-personnel, the semi-works organization includes a corps of experienced workmen to do the actual operating labor. These operators have responsibilities very different than those encountered by ordinary plant workmen, so that they may profitably be selected from men of the "foreman type." The difference in labor costs is more than counterbalanced by the better results obtained.

To complete the organization, a mechanic is sometimes assigned permanently to take care of all small jobs. If he is ingenious and resourceful, he can be of real help in avoiding expensive delays and in keeping mechanical features of the equipment in good condition.

Layout and Design

Buildings in which the small scale equipment is housed should be located near the research laboratories. They should be one-story structures, high enough to allow the use of temporary balconies for two or three levels of operation. In this way, the equipment for each new process can be set up to suit the requirements of that job and can then be dismantled without excessive cost. Instead of having one large room, good practice indicates the division of each building into several sections, separated by firewalls, so that operations can be kept separate. All service mains (steam, electricity, compressed air, etc.) may be carried outside of the building so that fire in any section will not put the other sections of the building out of commission. The changing nature of the work going on in these buildings makes it important that the design of floors, sewers and partitions be such as to resist much more severe service than might be encountered in plant practice.

Selection of equipment brings up an immediate question as to the proper size of apparatus. While economy of space and raw materials would dictate the selection of small units, the possibility of small-scale production for samples or for sale suggests relatively large pieces of equipment. Experience shows that it is best to start with as small a lay-out as will give the necessary design in-

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Abstracted from a paper presented by the author under the title of, "The Half-Way House," before the American Institute of Chemical Engineers, Chicago, June 14, 1933.

formation. After the early stages of development are successfully completed, a pilot plant may then be set up for checking details not settled in the very small scale. The larger unit will serve for producing the necessary samples for sales development.

After the chemical engineer has decided upon the scale of operation for a semi-works problem, he must decide upon the type of equipment to buy or build. The research chemist has a tendency to recommend what amounts to an enlarged copy (in metal) of the glass apparatus used in the laboratory. The engineering department, on the other hand, will prefer to see small models of commercial plant units so that the work will be done in exactly the same type of apparatus as will be included in the plant layout. Either of these courses *may* be desirable in certain instances. In many cases, however, the best procedure is to reduce the process to the fundamental unit operations and to carry these out in as simple pieces of equipment as possible.

Unit-Operation Equipment

Evaporation and distillation, for example, are two unit operations which may be carried out in a variety of specialized apparatus. For the semi-works, they can generally be handled satisfactorily in either a vertical kettle, a horizontal tank, or flat-bottomed vacuum pan. Such characteristics as foaming, precipitation of solids, and sensitiveness to overheating can be observed in these units. Generally a rational choice of plant equipment may then be made from these observations. Of the three evaporating units mentioned the ordinary vertical kettle, usually having an agitator, is used when some reaction is to be carried out before water or solvent is distilled off. The second type, the horizontal tank, is the cheaper unit per square foot of free liquid surface and can be used for a variety of purposes where solids do not precipitate. It is adapted to either pressure or vacuum work, can be heated by any of the usual sources of energy and can be fabricated from any sheet metal. Whenever special metals must be used, one of these first two types (kettle or tank) is almost certain to be advised.

The third member of the group, the vacuum pan or graining kettle, is of wide application. As commonly used, this evaporator is a cast-iron pan about 3 ft. in diameter and 1 ft. in depth. It is equipped with a slow-moving scraper agitator, a conical or dished cover and a large discharge door in the side wall, as well as a manhole in the cover. Although heating is generally done by means of steam or hot oil in the jacket, direct heating by electric units can be used on the unjacketed type of pan. Either atmospheric pressure or vacuum can be used. Solutions can be evaporated or distilled down to any desired concentration and solid residues can frequently be "grained" by means of the agitator. Cleaning of the unit is easier than with the cylindrical stills. Disadvantages are the relatively high cost compared to the other types, large amount of floor space required by the machine itself and by its motor and speed reducer, and difficulties in avoiding leaks.

Although such equipment as pipe stills, tubular evaporators (vertical and horizontal) and film type evaporators may be justified in certain cases, it is usually sufficient to carry out semi-works evaporation or distillation in one of the three types of equipment mentioned. The chemical engineer will then be able to decide what large scale apparatus is most economical to do the same job and to get the desired results.

For fractional distillations, the packed tower is so much less expensive than the plate column and can be set up so readily that it is generally chosen. Various tower packings are available, including Raschig rings of porcelain, stoneware, carbon and glass. Jack chain is now made in aluminum, brass and other metals besides steel, so that it can be used under a variety of corrosive conditions. The column itself may be made of any metal which comes in the form of pipe or tubing and may be connected with any of the three types of evaporators mentioned previously.

Since the semi-works fractionation is generally carried out to secure data for plant design, the accessories must be adequate and sometimes require expenditures which seem out of proportion to the still and column proper.

As a unit operation, drying ranks with evaporation and distillation in its importance to the semi-works. Here again, most of the problems are handled in a few simple types of equipment, namely: atmospheric shelf dryer, vacuum shelf dryer and, again, the graining kettle. It is pertinent to observe that these shelf dryers, while relatively simple, must be well designed. In too many cases irregular results can be traced to a home-made unit with improper distribution of heat or air.

As in the case of stills and evaporators, the absence of many well-known types of dryers in this list deserves explanation. Drum dryers, especially those used for vacuum work, are too expensive and require too much auxiliary equipment to be included in most semi-works budgets. Spray dryers, too, are generally considered in the same category unless the material to be sprayed adapts itself very easily to a simple nozzle and tower design. In general, problems where the character of the material suggests handling on rotary drums or in a spray, can be handled in the semi-works in the vacuum shelf dryer. For the final plant design drying tests can be made in the laboratories of the equipment manufacturers. Similarly, continuous dryers of the rotary and hearth types do not lend themselves readily to small-scale work.

Simplicity Also for Filtration

Filtration is the fourth unit process which the semi-works must handle. Here again, the simplest methods are usually the most satisfactory. For most small batches of material, the suction filter-box and for larger amounts, the 12-in. or 18-in. filter press would be selected. Low in first cost and easy to clean and operate, these pieces of equipment are of wide utility. From the results of small-scale filtrations made in them the plant designer may recommend whatever type of batch or continuous filter he chooses.

What has been said about the selection of equipment for these four unit operations common to the majority of processes applies to most of the other operations. That is, the policy recommended is to select equipment which will be simple and of wide application. In this way, expenditures for highly specialized equipment are eliminated in all but a few cases. Furthermore, the apparatus on hand is kept busy so that depreciation charges are kept to a minimum.

Certain features in the design of a semi-works plant require quite another attitude than the one just mentioned.

Methods for temperature control and instruments for measuring temperatures, pressures, rates of flow, etc., often involve more expensive apparatus on the small unit than is necessary for the plant. The basis of judgment must be the accuracy with which the desired data must be obtained. Unless results of experimental runs can be relied upon, they might better not be made. Accordingly, instrumentation is of primary importance.

With the emphasis which has been placed upon the use of the simple, widely applicable types of apparatus it might be assumed that the problem of semi-works design is merely to set up a sequence of kettles, pumps, filters, evaporators and dryers. This is true in enough cases to justify the insistence upon the policy of using such simple means wherever possible. There is, however, another side to the duties of the chemical engineer in this field of design. There are always cases in which an entirely new type of equipment must be developed. A recital of such developments would call the roll of the foremost achievements in new equipment, for practically all of our modern reaction vessels, stills, evaporators, dryers and means for supplying or removing heat have come through this semi-works phase.

Whether the semi-works equipment is to be selected from ordinary standard units or whether it requires something new in design and construction, one factor always comes up, namely, materials of construction. Laboratory tests are notoriously uncertain so that checking them up by actual use on a small scale pays large dividends. Just as in the case of laboratory corrosion tests, it is important to operate long enough to get past the initial corrosion stage and reach a steady state.

However simple or complicated the design of the semi-works equipment may be, it is a reasonable assumption that unexpected problems will arise when operation is started. Usually these problems require the application of chemical engineering principles for solution. Sometimes, they point to a variation in the chemical procedure and send the chemist back to the laboratory for further investigation. In any case, the success or failure of the process depends upon their solution.

Special Problems

In one case, for example, a product was made in a jacketed kettle, provided with agitation and a reflux condenser. Poor results were traced to local over-heating on the sides of the kettle. The difficulty disappeared when the size of the reflux condenser was doubled, steam up to the working pressure of the jacket was applied, and the material subjected to what seemed a terrific refluxing.

Another type of problem was presented when it was decided that the heat supply for a fractional distillation must be three times as much as could be supplied by the electric heaters on the horizontal still that must be used. The problem was solved by installing a vertical tubular heater, adjacent to the still and connected so that the liquid from the still flowed into the bottom of the heater, boiled up through the tubes and recirculated to the still.

Such illustrations of the unexpected problems which arise during semi-works operation could be multiplied indefinitely. In their solution, the cooperation of the chemist, the engineer and often of the operator is required. Gradually the process is standardized and the engineers get their data for plant design.

In laying out a development program, there is a general tendency to under-estimate what a new problem is likely to cost. It is important, therefore, to give consideration to some items of expense involved.

Small-Scale Economics

Very little can be said about the first cost of the semi-works area and its general facilities such as steam, air, water, electricity, sewers, etc. All of these services are usually required and due consideration must be given to the resultant overhead charge. The same thing, in general, may be said about buildings, that the item of rent will go on whether few or many processes are being studied. In other words, the semi-works budget will start with an overhead charge for rent and stand-by services.

The cost of equipment is an item which can usually be estimated fairly well for any specific process. Allowance must be made, of course, for changes which are required as the development proceeds. It should be borne in mind that semi-works apparatus is generally used for a variety of problems during its life and that a few extra dollars spent initially may greatly increase its usefulness. The same applies to materials of construction, since some special metal may be much more generally useful than ordinary carbon steel.

The maintenance of what our electrical friends call the "load factor" is of considerable importance in keeping down the cost of a semi-works plant. That is, where the director of research can schedule his work so that one problem follows another fairly closely, the amount of equipment can be kept at a minimum and the space used economically. On the other hand, when a number of problems must be handled simultaneously, duplication of expensive units may be required, followed by periods of idleness when the fixed charges go on with disconcerting regularity. This same "load factor" is of importance in connection with salary and labor charges.

One method for reducing semi-works costs is to have some products which can be manufactured during periods when experimental work is temporarily low. If such manufacturing permits building up of stocks which can be used for sale during periods of experimental activity, a portion of the overhead is thus eliminated from the budget.

The distribution of costs in semi-works plants is a matter of concern to many executives. Some companies charge off the entire budget to an overhead account. Others charge off only the cost of processes which are abandoned, placing the expenditures for successful developments in suspense accounts to be paid off by the final plant department when built and producing. In any event, it is important to keep accurate records so that there may be no illusions as to the cost of the development work.

To summarize, the functions of the semi-works include not only chemical engineering development, but also small-scale production and the training of plant operators. Responsibility for individual processes should rest on the research man who carried out the initial laboratory work. Equipment, in general, should be as simple as possible, useful in a wide variety of problems, although special apparatus and control facilities should not be stinted. Semi-works costs are high, but can be controlled by keeping both personnel and equipment occupied through careful planning.

BOOKSHELF

For Business Navigators

PROFIT ENGINEERING. By *C. E. Knoeppel,* Industrial Management Counsellor; with foreword by *Fred W. Shibley,* Vice-President, Bankers Trust Co.; and supplementary chapters by *Arthur J. Minor,* Consulting Engineer, and *E. St. Elmo Lewis,* Sales Counsel. First Edition. McGraw-Hill Book Co., Inc., New York and London. 326 pages. Price, $3.00.
Reviewed by *Chaplin Tyler*

"PROFIT ENGINEERING" is the author's term for business management, more particularly that phase of the management art dealing with budgets, sales forecasts and cost accounts. In no sense is this book an abstract work. It is intensely practical both in its objectives and in its exposition. The major thesis of the author is that a business exists for the purpose of making a profit, and that in turn a profit cannot be made unless the price of the goods or services produced is sufficient, at any given rate of output, to include all costs plus a return on the investment. No one will attempt to dispute such a thesis. The real difficulty is to determine what costs are, or should be, under various conditions of operation; or conversely, what conditions of operation are necessary in order to attain given costs and profits. The author therefore proceeds to tell how these factors can be determined, and how their control can be effected graphically. The principles involved, and the methodology should be acceptable to any business man. There is nothing radical, unsound or complex about the book.

The best analogy that the reviewer can draw is that "Profit Engineering" is to the business manager what the art of navigation is to the master of a ship. In calm seas or in moderately heavy weather the good "navigator" follows the art and avoids trouble. However, there are times—and the reader will need no reminder of such times—when that same good navigator gets into trouble despite his charts, despite the best of instruments, and despite the exercise of seasoned judgment.

The reviewer points this out, not with the idea of belittling the art of "Profit Engineering," but to record the opinion that *no* plan, however carefully thought out, can anticipate certain situations that confront every management. Furthermore, the reviewer seriously doubts whether rigid mathematical planning always is the best management policy. In other words, we are not living in a static world, therefore any plan, even though projected for a few months only, may have little more than disciplinary value. War games, drills and manœuvers are good for an army; and the corresponding exercise and make-believe are equally good for a business organization. But whether the "Reds" or the "Blues" win, we always wake up the next day facing a real enemy. It is the unknown factors, not the "charted" events, that make business exciting, interesting, and sometimes very profitable.

In conclusion, the reviewer is glad that he read this book, and he feels that it should be read by everyone who has a share of responsibility in a business. It is an interesting book, well written, as well as being substantial.

Alcohol and Man

ALCOHOL AND MAN. Edited by Haven Emerson. Published by the Macmillan Co., New York, 1932. 451 pages. Price, $3.50.
Reviewed by *S. D. Kirkpatrick*

AN EDITORIAL GROUP of seven leading physicians have collaborated with some 20 of their colleagues in the medical and associated sciences to produce an authoritative treatise for the educated laity concerned with the social and physiological "effects of alcohol on man in health and disease." The quotation is the sub-title for this impressive volume. The need for such a compilation arises from state and other laws for education and from the never-ending conflict of opinion and belief in the matter of regulating the sale of liquor. The authors have scrupulously avoided, even by implication, any reference to the traditional arguments and prejudices of this controversy.

Chemical readers will find much of interest and value in the discussions of pathology and toxicity. But the sections on denatured alcohol contain some glaring errors which will be noted by any chemist at all acquainted with this industry. On page 148 is a list of "chief" denaturants. Bichloride of mercury, so listed, has never been used; pyridin has been out of use for some years. Castor oil, kerosene, petroleum naphtha, camphor are listed as deadly poisons. One is prompted to wonder how any of us ever survived our childhood!

Dr. H. S. Martland in an interesting and otherwise accurate chapter on chronic alcoholism, falls into the vernacular of the congressman in referring to "poison liquor." He, too, is badly confused in the matter of denaturation, referring to "smoke" made from alcohol denatured with benzol, although such a formula has not been used since 1929. Throughout several chapters there is a much too careless and confusing use of the terms "wood alcohol" "commercial alcohol," and "denatured alcohol." In a book which will undoubtedly serve an important function in society, it is to be regretted that some of the authors were not better informed on the essential characteristics and functions of industrial alcohol.

Cellulose Ethers Bid for Fame

TECHNOLOGY OF CELLULOSE ETHERS. Vol. I-V. By *E. C. Worden.* Chemical Catalog Co., New York. 3,396 pages. Price, $45.
Reviewed by *Frederick C. Hahn*

IN RECENT YEARS a new class of cellulose derivatives has been bidding for an important position in the field of applied cellulose products. Cellulose ethers are little known generally, although during the past decade many patents have been issued covering their manufacture and use. During this interim the scientific publications have been relatively few but the constantly increasing size of the field has created a need for an orderly assembly of the available information on this subject. This need has been fulfilled by Dr. Worden's massive work, "Technology of Cellulose Ethers" which brings together, correlates, and makes available in useful form our present knowledge of this new class of cellulose derivatives.

The growing importance and rapid expansion of cellulose ethers in technology may be attributed primarily to their relatively great stability toward heat, water, alkalis and acids and to the fact that they are dissolved, softened, or plasticized by a much wider range and a cheaper class of liquids and solids than the other known types of cellulose derivatives, especially the organic esters typified by cellulose acetate.

Vol. I comprises a review and discussion, in chronological order, of the origin, advance, and the present position of cellulose ether technology up to the close of 1932. This method of approach gives the reader a good grasp and an appreciation of the subject, and the general trends in the field. This treatment is paralleled in Vol. II by a corresponding work on the interrelated cellulose esters. The space devoted to this general subject is well justified since the development of cellulose esters is so interwoven with that of the ethers that for thorough treatment of either subject a discussion of both classes of derivatives must be included.

Vol. III is devoted primarily to the purification, identification, properties, and constitution of cellulose and cellu-

losic materials. These topics are treated in an adequate, logical and concise manner with an exhaustive bibliography of the original literature. This section creates appreciation of the important role which raw materials play in the manufacture of cellulose ethers. The art of conditioning the cellulose, also, for etherification, which is an essential step, is treated at some length. In further reference to raw materials the next section covers the methods of manufacturing various alkyl and aralkyl etherifying agents and includes information on their chemical, physical, and physiological properties.

This volume next reviews procedures for laboratory and commercial scale production of methyl, ethyl, and benzyl ethers of cellulose and presents information on their solubility, plasticity, viscosity, and mechanical properties. Other sections discuss the mixed ethers such as alkyl-aralkyl and mixed ether-esters of cellulose and other carbohydrates such as starch. The last part covers amino, thiourethane, and xanthanilide compounds of cellulose as well as derivatives in which the substituted groups are ether-esters or inorganic radicals.

In Vol. IV the first 292 pages classify and list physical and chemical properties of over 2,500 solvents, non-solvents, plasticizers and softeners for cellulose ethers. This subject, it is believed, has been handled more exhaustively than in any similar work heretofore published. The space is well justified when one considers that all commercial applications of cellulose ethers necessitate first a dissolving, colloiding or plasticizing of the material with modifying agents.

The second and third chapters in Vol. IV, comprising 585 pages, are devoted to the technical applications that have been proposed or exploited for various cellulose ethers, the former covering synthetic fiber formation and the textiles made therefrom, the latter covering other uses. The various steps in the transformation of cellulose ethers into finished filament are treated at some length. After-treatments, delustering, weighting, dyeing, printing, etc. of the rayon are included. The other uses proposed for cellulose ethers, such as lacquers, plastics, coating compositions, etc. are so numerous as to impress one with the immensity of the field.

A few comments are desirable on Vol. V. The review of over 50,000 references to patents and literature articles is evidence of the exhaustiveness of this treatise. The relatively wide distribution of references to foreign literature also shows that the work covers the world development of the subject and not primarily American development. Although the reviewer is not in a position to vouch for the accuracy of all the references, the impression has been gained through the use of the volumes to date that great care has been taken in the preparation of indices and bibliographies. The inclusion of a list of abbreviations at the beginning of each volume greatly adds to the utility of the volumes.

It is the reviewer's belief that "Technology of Cellulose Ethers" will prove to be an invaluable book of reference to those interested in both the industrial and the academic phases of cellulose derivatives. Even the specialist in a limited field will find the volumes of value since he may be able to obtain all the published information concerning his particular topic. This treatise, which is the only published work of its kind, supplements the author's five volume work on the "Technology of Cellulose Esters" and, with it, brings up to date a practically complete coverage of the respective subjects.

Analysis Up to Date

PRESCOTT AND JOHNSON'S QUALITATIVE CHEMICAL ANALYSIS. By Messrs. *Roy K. McAlpine* and *Byron A. Soule*. D. Van Nostrand Co., Inc., New York. 696 pages. Price, $4.50.

BASING THEIR WORK on the text by Prescott and Johnson the authors have undertaken to modernize a classic that still holds an honored place among chemical textbooks. The rapid development of physical chemistry and the advance of organic synthesis and industrial chemistry have tended to draw the chemist's attention from the art of analytical chemistry, a field which formerly absorbed many graduates.

In the revision the excellent features of the older textbook have been retained, with expansion and modification of certain parts to make it conform more closely to the present courses in qualitative analysis. Detailed directions have been given for the analysis of solutions and for dry unknowns, covering 23 metals and eleven acid radicals. The numerous references which made the older book so valuable have been brought up to date.

ELEMENTARY QUANTITATIVE ANALYSIS. By *H. H. Willard* and *N. H. Furman*. D. Van Nostrand Co., New York City. 406 pages. Price, $3.25.

ALL THEORY and laboratory procedures required in the first year's work of quantitative analysis is included in this volume. No attempt has been made more than to mention the physiochemical methods involved, but much emphasis has been placed on the theoretical principles underlying the methods included. The methods of calculation which are most efficient have been treated at the points in the text where instruction in this branch of the subject is most needed; sets of problems and review questions have been provided. Summaries of literature sources and numerous references to the original literature have been included to facilitate study of the methods in detail.

VOCATIONAL GUIDANCE IN ENGINEERING LINES. Sponsored by American Association of Engineers. The Mack Printing Co., Easton, Pa. 521 pages. Price, $2.50.

Reviewed by *B. H. Strom*

FEW PROFESSIONS demand more aptitude and natural ability along definite lines than that of the engineer; few call for greater love of the work and devotion to the job at hand; and few hold out a smaller promise of fame and material gain, in proportion to efforts expended. With these facts in mind, the need for guidance of those planning to take up this vocation is obvious. Proper guidance would undoubtedly offer the best opportunity to reduce the large percentage of eliminations and failures in the first two years of undergraduate engineering courses.

To accomplish this, the American Association of Engineers several years ago appointed a committee on vocational guidance, and the idea of a book on the subject was conceived. The various chapters, covering every conceivable phase of engineering, are contributions of men eminent in their fields. Theodore B. Wagner has written the chapter on chemical engineering, and E. P. Mathewson has dealt with metallurgical engineering.

Students and their parents, vocational advisers, and members of the faculties of engineering schools should find the book of great value; but even the practicing engineer may derive much pleasure from reading this well-written review of the profession.

DIE ALKALICHLORIDELEKTROLYSE IN DIAPHRAGMAZELLEN. Part I. By *Gösta Angel*. J. Beckman Förlag, Stockholm, Sweden. 126 pages. Price, 12 Rm.

Reviewed by *Axel Heilborn*

THEORETICAL COMPOSITIONS of catholyte and anolyte in diaphragm cells have been calculated with consideration of such factors as volumetric concentration of the liquor by the formation of the hydroxide; evaporation; decrease in the sodium chloride content; and current efficiencies. The results are presented in tables and curves, as functions of the sodium hydroxide content of the catholyte. The author then discusses the results obtained in a cell with horizontal diaphragm, to determine the current efficiency under varying conditions, also as a function of the sodium hydroxide content of the catholyte. The efficiency obtained remained constant, 97 to 98 per cent, up to a concentration of 3.9 mol. of NaOH in the catholyte, and then dropped at a constant rate. This picture is different from Billiter's classical curves.

Results obtained are constantly compared with previously published findings by other scientists. The last chapter gives a résumé of data for potassium

chloride electrolysis. Part II of this work is expected to appear in a few months. If the problems are as clearly and logically discussed as in Part I, the book will be a welcome addition to the bookshelf of the electrochemist.

Century of Progress Series

SPARKS FROM THE ELECTRODE. By *C. L. Mantell*. The Williams & Wilkins Co., Baltimore. 127 pages. Price, $1.

APPLICATION of electric power to chemistry has led to the establishment of one of the major industries of the United States. This book deals with the important phases in this development, the production and refining of metals, electroplating, alloy manufacture, production of abrasives and other synthetic materials frequently superior to similar products found in nature.

EARTH OIL. By *Gustav Egloff*. The Williams & Wilkins Co., Baltimore. 158 pages. Price, $1.

PRODUCTION of petroleum affects almost every human activity of today. Oil is the fuel that has made possible the high tempo of modern existence, and oil furnishes the lubrication without which our high-speed machinery would quickly come to a stand-still. The romantic history of this giant industry, representing an investment of over twelve billion dollars, is entertainingly presented in this little volume.

DESIGNING FOR ARC WELDING, a Symposium of the Prize-Winning Papers in the Second Lincoln Prize Competition. Lincoln Electric Co., Cleveland, Ohio. 450 pages. Price, $2.50.

CONTAINING five sections covering the use of arc welding in machinery, shipbuilding, bridges, large containers and pipes and fittings, this volume makes available to designers in many fields the best papers from a group of some 400 that were submitted in the recent $17,500 competition sponsored by the Lincoln Electric Co. Each chapter is the product of an authority in that field. Designs are illustrated with numerous drawings and photographs and each paper stresses in detail the savings in costs that resulted from the methods used. Assuming that arc welding were used as extensively as possible in all industries covered by the papers, a resume of the savings indicated would reach the estimated total of a billion dollars per year.

THE ALLOYS OF IRON AND MOLYBDENUM. By *J. L. Gregg*. McGraw-Hill Book Co., New York. 507 pages. Price, $6.

INTEREST in molybdenum as an alloying element is decidedly on the increase. The purpose of this timely monograph is to present, in ready form, the important facts on molybdenum steels and other of the iron-molybdenum alloys, with or without other alloying elements. Most of this material up to this time has not been available in book form. Molybdenum betters the mechanical properties of both nickel and nickel-chromium steels; claims are also made that it increases their resistance to corrosion. Among ternary steels, those containing molybdenum have found considerable favor. Molybdenum in special cast irons produces highly desirable effects, and high-test cast-irons of this type appear to have real merit.

BRITISH CHEMICALS AND THEIR MANUFACTURERS. The Association of British Chemical Manufacturers. London. 429 pages.

THIS IS the official directory of the association. It is printed in five languages besides English: French, German, Italian, Portuguese, and Spanish, and is available, without charge, to all buyers of chemicals, upon request to the association's office, 166 Piccadilly, London, W.1. Official Directory of the British Chemical Plant Manufacturers' Association. 429 pages. Listings of equipment makers followed by advertisements of member concerns. Free upon request to association offices.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

A Study of the Deterioration of Book Papers in Libraries, by Arthur E. Kimberly and Adelaide L. Emley. Bureau of Standards Miscellaneous Publication No. 140; 5 cents.

Iron and Steel Industry and Trade of India, by Geo. C. Howard. Bureau of Foreign and Domestic Commerce, Trade Information Bulletin 816; 5 cents.

Report on Production and Sales of Dyes, Other Coal-Tar Chemicals, the Noncoal-Tar Resins and Certain Barbituric Acid Derivatives, 1932. U. S. Tariff Commission release; mimeographed.

Tariff Bargaining Under Most-Favored-Nation Treaties. Tariff Commission Report No. 65, Second Series; 5 cents.

Russian Asbestos. Tariff Commission Report No. 67, Second Series; 5 cents.

Use of the Exponential Yield Curve in Fertilizer Experiments, by W. J. Spillman. Department of Agriculture, Technical Bulletin 348; 10 cents.

Wages and Hours of Labor in the Slaughtering and Meat-Packing Industry, 1931. Bureau of Labor Statistics, Bulletin No. 576; 15 cents.

List of Publications of the Department of Commerce, Edition of May, 1933.

Painting on the Farm, by H. P. Holman, Department of Agriculture, Farmers' Bulletin 1452; 5 cents.

Production of Explosives in the United States in 1932, by W. W. Adams and L. S. Gerry. Bureau of Mines Technical Paper 558; 5 cents.

Rubber Industries Statistics. Census of Manufactures, 1931, Bureau of the Census; 5 cents. Includes data on rubber tires and inner tubes, boots and shoes, rubber, rubber goods other than tires.

Explosives Statistics. Census of Manufactures, 1931, Bureau of the Census; 5 cents. Includes data on ammunition and related products, explosives, firearms, fireworks.

Drug Retailing. Census of Retail Distribution, Bureau of the Census, Distribution No. R-78; 5 cents.

Fuel Production Statistics for 1931—Separate pamphlets from Bureau of Mines on: Natural Gas, by G. R. Hopkins and H. Backus, 5 cents; Coke and Byproducts, by F. G. Tryon and H. L. Bennit, 5 cents; Coal, Bituminous and Pennsylvania Anthracite, by W. H. Young, F. E. Berquist, and others, 10 cents.

Starches. Bureau of Foreign and Domestic Commerce, Foodstuffs Division, 1933 Revised Edition; mimeographed, 10 cents. Gives general information and statistics. Copies may be obtained from the Foodstuffs Division only.

Vermiculite, by A. V. Petar. Bureau of Mines Information Circular 6720; mimeographed.

Petroleum Refineries, Including Cracking Plants in the United States Jan. 1, 1933, by G. R. Hopkins and E. W. Cochrane. Bureau of Mines, Information Circular 6728; mimeographed.

Limestone, by Oliver Bowles and D. M. Banks. Bureau of Mines Information Circular 6723; mimeographed. Part I, general information.

Identification of Cerussite and Anglesite, and Flotation With Galena, by F. D. DeVaney and R. E. Evans. Bureau of Mines, Report of Investigations 3214; mimeographed.

Volatilization of Impurities From Zinc Concentrates, by G. L. Oldright and others. Bureau of Mines Report of Investigations 3218; mimeographed. Contains also a chapter on thermodynamic calculations, further theoretical study of the separation of cadmium and zinc, by Chas. G. Maier.

Investigations During 1932 of Combustibles in Manholes in Boston, Mass., by G. W. Jones and others. Bureau of Mines Report of Investigations 3213; mimeographed.

Limits of Inflammability of Natural Gases Containing High Percentages of Carbon Dioxide and Nitrogen, by G. W. Jones and R. E. Kennedy. Bureau of Mines Report of Investigations 3216; mimeographed.

Evolution of Methane Detecting Devices for Coal Mines, by L. C. Ilsley and A. B. Hooker. Bureau of Mines Information Circular 6733; mimeographed.

Comparison of Methods for Determining the Friability of Coal, by H. F. Yancey and R. E. Zane. Bureau of Mines Report of Investigations 3215; mimeographed.

A Study of "Bottom-Hole" Samples of East Texas Crude Oil, by Ben E. Lindsley. Bureau of Mines Report of Investigations 3212; mimeographed.

Flotation Processes for Cleaning Fine Coal, by H. F. Yancey and J. A. Taylor. Bureau of Mines Information Circular 6714; mimeographed.

Washability Studies of Coal From the Mary Lee Bed at the Bankhead Mine, Bankhead, Ala., by A. C. Richardson and B. W. Gandrud. Bureau of Mines Report of Investigations 3206; mimeographed.

The Cleaning of Fine Coal From the Mary Lee Bed at the Porter Mine, by A. C. Richardson and B. W. Gandrud. Bureau of Mines Report of Investigations 3209; mimeographed.

Estimate of the Gas Reserves of the Oklahoma City Oil Field, Oklahoma County, Okla., by H. B. Hill and E. L. Rawlins. Bureau of Mines Report of Investigations 3217; mimeographed.

Bibliography on Geology and Mineral Resources of Turkey, by L. Jones. Bureau of Mines unnumbered document; mimeographed.

Iron Ore in the Red Mountain Formation in Greasy Cove, Alabama, by Ernest F. Burchard. U. S. Geological Survey Circular 1; mimeographed.

PLANT NOTEBOOK

Basket Centrifuge Inclosed By Novel Means

SEPARATION of liquids from solids by means of a centrifuge offers, in the cases where dilute aqueous solutions are handled, no particular difficulty. This operation, however, may become very troublesome when the fumes are noxious, or more particularly where the material in the basket is harmed by contact with air. This problem is a very serious one in nitration of cotton; not only are the fumes harmful, but in addition the pumping action of a centrifuge at full speed causes large quantities of moist air to be drawn through the cotton, partial denitration resulting.

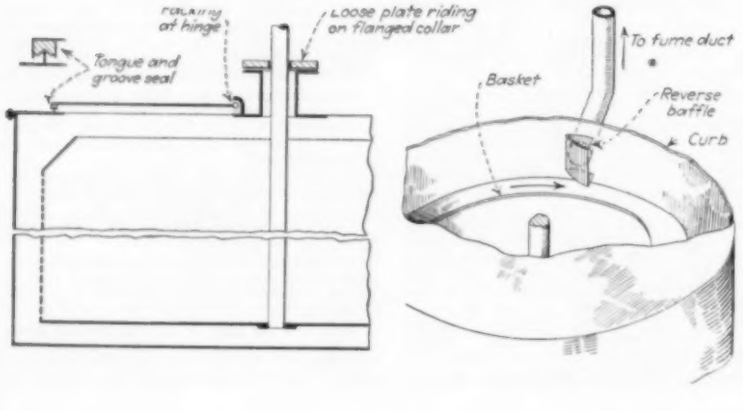
Engineers in the plant of a large nitrocellulose manufacturer solved both of these difficulties by a very ingenious scheme, and in the past several years have practically eliminated this trouble spot. First of all, the centrifuge curb was made as tight as possible, and in order to do this, the loose cover was provided with packing at the hinge and a tongue-and-groove seal around its edge. The curb was provided with a short, flanged collar where the spindle passes through, and a flat aluminum plate mounted loosely on the spindle. This plate oscillates with the spindle, but does not revolve with it.

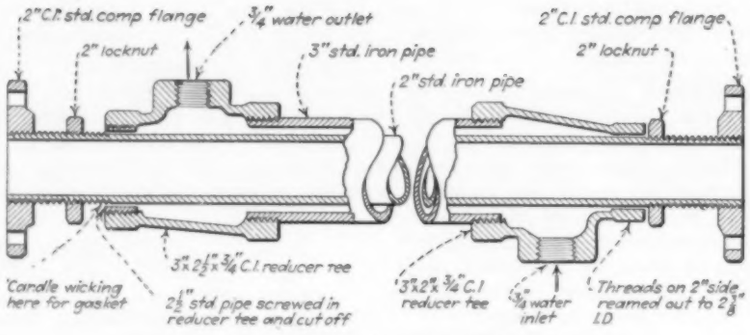
With the fume duct opening at the rear of the cover of the usual design, the basket still acted as a pump, in spite of its more or less tight cover, discharging air into the fume duct. Of course the opening might have been provided with a damper and shut off during wringing, but this would have required manual control, and would also have been dangerous, as sometimes the contents of the basket decomposes with the formation of immense quantities of dense brown fumes. At such a time few workmen would think to open a fume-line damper and someone would probably be hurt.

A type of automatic damper was the answer, as shown in the sketch. It will be seen that this is a "reverse baffle," so shaped and placed that the basket at full speed induces no draft up the fume duct. The reverse baffle actually neutralizes the centrifugal pumping action of the basket. With ingress and egress of air practically eliminated, denitration and deleterious effect on the nitrocellulose are reduced nearly to the vanishing point.

When the centrifuge is stopped, the cover lifted, and the basket unloaded manually, the fume opening, under its slight suction from the stack, carries the fumes inward and away, thus protecting the workmen.

Cover packing, spindle seal and reverse baffle applied to centrifuge




2"C.I. std. comp flange
¾" water outlet
2" locknut
3" std. iron pipe
2" std. iron pipe
2"C.I. std. comp flange
2" locknut
3"x2½"x¾" C.I. reducer tee
Candle wicking here for gasket
2½" std pipe screwed in reducer tee and cut off
3"x2"x¾" C.I. reducer tee
¼" water inlet
Threads on 2" side reamed out to 2⅜" I.D.

Two methods of jacketing semi-plant condenser

Semi-Plant Condenser of Standard Fittings

By G. E. Seavoy
Chemical Engineer With P. F. Crahan
New York City

THIS CONDENSER has been found to be especially convenient for semi-plant development work and is easily constructed of standard fittings. A 2-in. x 5-ft. condenser of this design was used to condense mercury vapors in a vacuum system and proved very satisfactory. For this purpose it was advisable to jacket the condenser and have a minimum of joints of any kind. Two ways are shown in the figure how this can be accomplished.

In the way illustrated at the left there is required, in addition to common wrenches, simply a hack saw to cut the 2½-in. pipe after it is screwed into the 3x2½x¾-in. reducer tee. The face may then be filed, but this is not absolutely necessary. From a glance at the standard pipe specifications, it will be evident that the difference in diameters between the inside of the 2½-in. pipe and the outside of the 2-in. pipe is 0.094 in., or the clearance is about 0.047 in. A candle-wicking gasket drawn up by a 2-in. lock nut on the condenser pipe is an amply tight joint to hold ordinary water pressure.

The method shown at the right uses a 3x2x¾-in. reducer tee. The threads on the 2-in. opening of the tee are reamed out to about 2⅜-in. diameter inside so as to give a close slip-on fit over the 2-in. condenser pipe. A candle-wicking gasket drawn up by a lock nut is also satisfactory here.

Lines From a Draftsman's Notebook

By Alan Osbourne
Mechanical Engineer
Boston, Mass.

AN ARTICLE in the February issue, on the subject of dye plant machinery and written by "A Post-Graduate," was to me one of the most interesting things *Chem. & Met.* has published. It happens that I recently did a little thinking along similar lines and I should like to set down here some of my conclusions.

Chemical machinery designers could well use a few Saturday afternoons visiting plants and factories to help them visualize the conditions under which their apparatus must operate. Their equipment must often withstand the tender mercies of operators unaccustomed to mechanisms; it must sometimes be repaired by men clumsy from weariness and lack of sleep. Added to this, the tie-up of a machine may shut down an entire plant. Hence, in the designer's hands is the important problem of making his machinery not only foolproof, but breakdown-proof to the last degree.

One great cause of machine failure is faulty bearings. There are few places, I believe, where anti-friction bearings, carrying their own protection and lubricant, are not justified in the long run. Where necessary, standard ball bearings may even be obtained in stainless steel. The substitution, unfortunately, doubles the price and halves the possible load, but such bearings are available if needed. Another method to avoid annoyance is to choose properly between bolts and studs for fastenings. Studs make for rapid disassembly, but to any man who has had to drill out a broken stud, the thought of bolts is attractive. The "too-strong" operator may be foiled in his efforts to twist off the nut by using no bolts or studs smaller than ½ in.

Corrosion remains the *bête noir* of the chemical works, although some of his teeth have been drawn. Gold and silver plating, attractive to every tyro, has not been outstandingly successful. Stainless steels have proven extremely useful, but even they must be used with caution. Machine work on them is similar to that on Monel, and since most of them are non-magnetic, parts made from them may be confused with the latter. I once made a costly mistake of designing a ground shaft of austenitic steel to run in a bronze bearing. The effect was as bad as if steel were running on steel. Speaking of shafts, hard-surfacing is very effective in reducing the damage of abrasives.

Wood is an excellent engineering material in all places where cellulose is unaffected. For a lightweight wood, Philippine mahogany, and for a heavy, Australian ironwood, seem to me best for the manufacturer. Contrasting with maple, Philippine mahogany does not warp even in hot solutions. Lignum vitæ, that standby of marine men, seldom lubricates effectively in hot solutions and has led to serious trouble at times. California redwood is excellent in the construction of tanks, being easily worked and very resistant to rotting. Its disadvantages are a tendency to split and the fact that its slivers are slightly poisonous. The latter fault it shares with teak.

Borosilicate glass would seem to have great possibilities for the future. It is an almost perfect material for our industry. A primary disadvantage lies in the need for large production to distribute the cost of molds. Rubber, again, is a material of great interest, and comparatively inexpensive. A quarter-inch of rubber is a good general covering. One great advantage of the rubber pipe now being produced is that it does not carry vibration from one machine to the next.

Here and There

Now for a few even more random observations. Where everything else fails, wool yarn is often a successful shaft packing. In general, machinery adapted to chemical use from metallurgical industries is very successful, while the reverse is likely to be true of electrical machinery. The chemical plant designer on the one hand is faced with rapid obsolescence, and on the other with the most severe conditions encountered in any industry. Money must not be tied up in obsolete equipment and yet, while it is in use, equipment must withstand deterioration. As good a rule as any is that for an old, established branch of the industry, machines should be more rugged and massive than for recent developments still in the process of constant change. In general, I believe that the construction should be of a massiveness comparable to marine machinery.

The production of chemical machinery is founded on honest building and research, and receives in its time its due and moderate reward. It is much safer than a mass production business for an organization can make mistakes in the design of equipment and still recover if it does not have too many machines fail at the same time. But when one knows the faults in his equipment, it is only fair, as well as profitable, to warn the operator. Trouble can often be avoided in this way, in the early stages of a design, while the faults are being ironed out in later machines.

Handling an Emergency Pumping Job

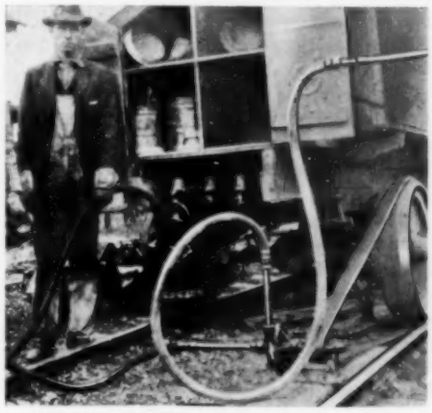
By C. O. Sandstrom
Thermal Engineering Co.
Los Angeles, Calif.

RECENTLY I observed a tie-up of a construction job where a very simple pumping expedient, such as I used a number of years ago, would have saved both time and money. Not long after the War I was carrying out some experiments in an unfinished chemical plant, using a rotary kiln that was fired with distillate because of a damaged trestle over which a car of fuel oil could not be delivered. The distillate was brought in by 500-gal. tank truck as required. With the first order I informed the seller that the distillate would have to be pumped to an elevation of 25 ft. I was assured that a pump would be provided.

When the first load arrived, the driver produced a small hand-propelled gear pump—the kind used to transfer oil from barrels to other containers at the same level, and entirely inadequate to lift 500 gal. to a height of 25 ft. It was 4 p.m. on a December day with darkness coming on. We were faced with the prospect of returning the load of oil and delaying our work until an adequate pump could be provided.

A hurried search in the storeroom disclosed a ¾-in. centrifugal pump and a length of belt sufficient for the purpose. A shoe-string served as belt lacing. The pump was nailed to a plank and, jacking up one rear wheel of the truck, we slipped the belt over the tire. The plank was nailed to the railroad ties and the belt aligned by "steering" the far end of the plank. The end of the suction hose was submerged in the pail which was hung from the spigot and filled in the usual manner. Through this means the 500-gal. load was transferred to the storage tank in less than half an hour.

Tank truck supplying pump power



NEW EQUIPMENT

Equipment Briefs

At its Sharon, Pa., shops, the General American Transportation Corp., Chicago, Ill., is building for the DuPont Company six special tank cars of 11,000 gal. capacity for the transportation of metallic sodium. The metal at present is shipped in 50-gal. drums.

McLeod & Henry Co., Troy, N. Y., has introduced a special grade of high-temperature-resistant firebrick under the name of Oil-Brand "Steel Mixture," intended particularly for use in oil-fired furnaces. The new brick is said to withstand temperatures far in excess of 3,000 deg. F.

For service somewhat less severe than that for which its No. 80 firebrick is intended, the Babcock & Wilcox Co., New York City, has developed the B. & W. 80 Junior. The new brick has a melting point of 3,175 deg. F., approximately 100 deg. higher than that of representative firebrick. Load-carrying capacity and spalling resistance are reported as high.

Plibrico Jointless Firebrick Co., Kingsbury St., Chicago, Ill., has introduced a new observation port with a glass window for eye protection and a divided cover which closes automatically when the handle is released. It is used for observing flame conditions in boilers and industrial furnaces.

Air volumes from 50 to 2,000 c.f.m., with pressures up to 150 lb. and vacuums up to 29.85 in. mercury, are possible with a complete line of rotary air compressors and vacuum pumps of the multicellular, sliding-vane type, recently announced by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The new machines are available in both air- and water-cooled designs.

While primarily intended for typical splash-proof installations, a new splash-proof motor recently developed by the Century Electric Co., St. Louis, Mo., is also recommended for outdoor use where protective buildings or covers are not available.

Hot-rolled, seamless steel boiler tubes, described as having exceptional ductility, have recently been put on the market by Jones & Laughlin Steel Corp., Pittsburgh, Pa. Both inside and outside surfaces are said to be unusually smooth.

After having, for many years, supplied nickel-clad steel sheets for special fabricating purposes, H. Boker & Co., New York City, is now prepared to offer these sheets in thin gages, both hot and cold rolled, to the trade in general. Cold-rolled, polished sheets are available as thin as 32 U.S.S. gage.

Glass-Block Lintel

Corning Glass Works, Corning, N. Y., is responsible for the production and erection of a large glass lintel, 55 ft. long and 15 ft. wide, which crowns the entrance to the new 69-story RCA Building at Rockefeller Center, New York City. The lintel is composed of 240 blocks, weighing from 70 to 100 lb. each. The blocks were cast in metal molds, carrying out a design in bas relief which was first produced by a sculptor to a scale of $\frac{1}{4}$ size, after which it was reproduced in modeling clay from which plaster casts were made.

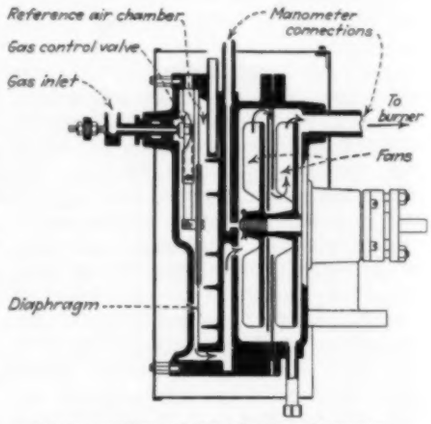
The glass used is Pyrex and the blocks accurately molded to size in order to give extremely thin joints. The jointing material is Vinylite resin and the supporting framework steel, coated with zinc, then lead and finally Duco enamel.

In the pouring of the blocks the molten glass was immediately pressed by a plunger to glass thicknesses ranging from 1 to $4\frac{1}{4}$ in. Because of the variation in volume of the casting, it was necessary to cast several duplicates at one time to secure perfect blocks. A total of 84 molds was required.

Pyrex glass lintel during erection at the RCA Building

Compensating Gravity Meter

Two recent developments have been announced by the American Meter Co., Erie, Pa. The new Metric Gravitometer, a recording instrument for continuously measuring the specific gravity of a gas, is described as being the only instrument for this purpose which automatically corrects for variations in both temperature and in atmospheric pressure. An accompanying drawing illustrates the principle of the new instrument. Very briefly, it consists of three chambers inclosed within an asbestos-lined jacket, so that the temperature of all three chambers is the same. The first chamber, at the extreme left, serves for the admission and control of the gas.



Cross-section of Metric Gravitometer

The second chamber (in the center) is sealed, containing a definite quantity of air under a pressure of 30 in. mercury at a temperature of 60 deg. F. The third chamber contains a pair of fans rotated by a constant-speed motor for the measurement of the density of the gas.

In operation, gas enters through a small reducing valve where its pressure is adjusted by means of the diaphragm and valve to be exactly equal to that of the air in the sealed chamber at the temperature of operation. Gas then flows into the center of the two-stage blower from which it is expelled to a burner. The pressure differential between the inlet and outlet of the blower constitutes an exact measure of the density of the gas (and of the specific gravity since the temperature and pres-

sure equal that of the standard). It is this differential which is recorded by the instrument.

This company has also developed a line of integrating orifice meters and flowmeters which are also sold under the trade name of "Metric." The "orifice" instrument consists of a Westcott orifice meter equipped with an integrator which gives a totalized indication of the quantity of gas flow, corrected for pressure variations. The "flowmeter" is similar except that the pressure spring has been omitted.

Glyptal-Treated Cable

A new cable insulated with Glyptal-treated cloth, to resist oil and withstand high temperatures, has recently been announced by the General Electric Co., Schenectady, N. Y. In addition to its oil and heat resistance, the new cable is said to be unusually flexible and tough. This insulation is now available in all types.

Light-Weight Fittings

Fittings in sizes up to 16 in., for pressures up to 200 lb. per sq.in., and made in 10-gage steel by welding, have recently been announced by the Taylor Forge & Pipe Works, P.O. Box 485, Chicago, Ill. These fittings are die-formed and present a smooth surface with minimum resistance to flow. Center to center dimensions conform with the 125-lb. American standard. The fittings are available either with or without flanges and include ells, tees, crosses, Y's, reducers and combinations.

Improved Flow Controller

International Filter Co., 59 East Van Buren St., Chicago, Ill., has developed an improved flow controller (called Type CD) for use in industrial and water-works plants, where maintaining a uniform rate of flow is necessary or desirable. An accompanying drawing illustrates the principle of the new controller, which is seen to consist of a venturi tube for measuring the flow rate, in combination with a hydraulically actuated valve and a pilot-controlled "Actuator." Operation of the controller is as follows: The differential established by the venturi is transmitted by a small bypass flow to the two sides of a balanced diaphragm which is connected to the pilot valve. This flow passes through two constant orifices in the diaphragm. Should flow increase, the diaphragm will be forced upward, while a decreasing flow will cause it to move downward. In either event, the control pilot will admit pressure water to the control valve cylinder, thus maintaining the valve opening at a point which will just keep the diaphragm at its balanced position. The flow rate is readily adjusted by varying the size of the variable orifice shown in the drawing.

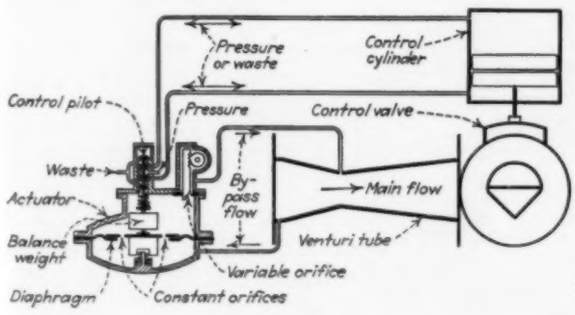
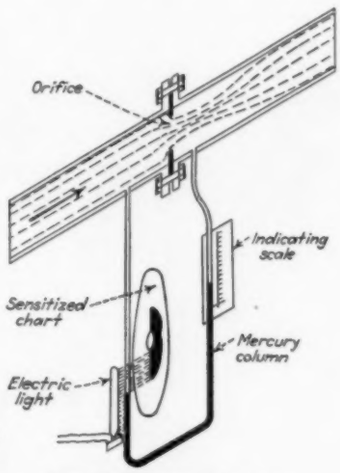


Diagram of new Type CD flow controller

Light-Beam Recorder

Elimination of all moving parts, except for the clock system, is accomplished in the new "Foto-Flo" recording flowmeter recently put on the market by the Trimount Instrument Co., 332 South La Salle St., Chicago, Ill. This is accomplished by the use of a transparent mercury U-tube, which operates in front of an indicating scale and also is interposed between an electric light and a sensitized chart. Depending on the pressure differential set up by an orifice in the line, the mercury conceals more or less of the light from the chart and what light falls on the chart prints on it a continuous record of the differential. This construction is illustrated diagrammatically in the accompanying drawing.



Operating principle of new "Foto-Flo" meter

Simpson 6-ft. diameter intensive mixer

Muller-Type Mixer

After a number of years of application in various industries, the Simpson Intensive Mixer has been developed to a point where it is now being offered for use in chemical plants, in the mixing of plastic and semi-plastic masses of all kinds. This mixer is not a grinder since the mixing rollers, or mullers, are adjustable to from 0 to 2 in. above the pan and thus eliminate grinding of the material. Details of construction can be noted in the accompanying top view. The mixer consists of a stationary pan with a double discharge, containing two mulling wheels and two plows. Material, after being properly mixed, is discharged through the doors by the action of the plows. Through their action during mixing the material is turned over repeatedly and subjected to a vigorous rubbing action by the mullers.

These machines are available in sizes ranging from an 18-in. laboratory model to a 9-ft. mixer which discharges continuously at the center.

Improved Chemical Stoneware

A new grade of chemical stoneware, known as "Lectrovac" Chemicalware, has recently been announced by the United States Stoneware Co., Akron, Ohio. Its physical properties, according to the manufacturers, have been greatly improved through the use of certain improved electrical, mechanical and chemical practices. During mixing the clays are given an electrolytic treatment for the segregation of impurities and this is followed, in the case of extruded ware, by an electrical process described as cathode film lubrication. It is believed that this is a process of electrophoresis whereby some of the moisture is carried to the surface of the clay column as it passes a cathodic die.

Further improvements include de-air-

ing with equipment developed by this company, and the addition of new body constituents which contribute to the thermal-shock resistance of the ware.

Barrel-Filling Equipment

To facilitate and increase the accuracy of barrel- and can-filling operations in the packaging of oils and similar products, S. F. Bowser & Co., Fort Wayne, Ind., has adapted its Xacto meter to the problem. This meter attains precise displacement by what is known as the "strike measure" principle. Five cylinders, each holding 0.1 gal. when full, contain pistons driven from below by a wobble plate. At the precise instance when any one of the pistons reaches its bottom dead center, a circular valve plate slides across the open upper end of the cylinder, cutting off the inlet and insuring an exact quantity of fluid within the cylinder. By means of an easily read dial, the stroke of the pistons may be regulated exactly to ensure the delivery of a definite volume at 60 deg. F., regardless of temperature or specific gravity variations. This meter is available in various styles with volume totalizers, volume indicators or package totalizers and various filling auxiliaries. It is also built in a smaller and simpler type for the filling of small standard packages.

Indicating Flow Meter

For indicating differential pressure, The Foxboro Co., Foxboro, Mass., has developed a new, inexpensive gage for which compactness, easy readability, accuracy and low initial and upkeep costs are claimed. The instrument is calibrated in per cent of total flow.

Indicating Foxboro flow meter

Motorized Control

A practical means of obtaining modulated control of heat, cold, humidity or air flow, is incorporated in the new type M 94-1 Modutrol motor introduced recently by the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. This motor is an extension of the principle originally described on page 604 of the October, 1931, issue of *Chem. & Met.* The motor operates a lever which may be used to position dampers of various sorts or to operate gas or liquid valves. The motor is actuated by potentiometer controllers made by this company which, with a change of temperature, pressure or other variable unbalance a potentiometer circuit. This unbalance actuates a normally balanced solenoid, closing contacts which cause the motor lever arm to move in the direction desired, and to move a distance proportional to the amount of unbalance. Hence the lever arm takes up a position which is proportional to the demand for heat or other medium.

MANUFACTURERS' LATEST PUBLICATIONS

Apparatus. Bausch & Lomb Optical Co., Rochester, N. Y.—6 pages describing a new colorimeter and turbidimeter known as the Scopometer.

Apparatus. R. Fuess, Inc., 245 West 55th St., New York City—8 pages on a new universal optical bench introduced by this company.

Bakelite. The Bakelite Corp., River Road, Bound Brook, N. J.—16-page booklet describing in a non-technical manner the manufacture and use of Bakelite resinoids.

Burners. Lee B. Mettler Co., 406 South Main St., Los Angeles, Calif.—Section 1, Catalog 4-1-33—32 pages on industrial gas burners and combination oil-gas burners made by this company.

Cad-A-Loy. E. I. duPont de Nemours & Co., R. & H. Chemicals Dept., Wilmington, Del.—23-page manual on the operation of plating installations using this cadmium-mercury process for plating iron and steel parts.

Compressors. Ingersoll-Rand Co., Phillipsburg, N. J.—Form 3063—20 pages describing a new single-stage, belt-driven compressor for heavy duty service at discharge pressures up to 150 lb.

Control. Northern Equipment Co., Erie, Pa.—Booklet 133—8 pages describing this company's double-control regulator for feedwater.

Cork. Mundet Cork Corp., 450 Seventh Ave., New York City—June 1 price list—16 pages on cork pipeline coverings and molded fitting covers made by this company.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—Publications as follows: GEA-1746, Glyptal-cloth insulated cable; GEA-1755, CR 7505-K1 photoelectric relay; GEA-1761, motor starting switches; GEA-1765, fractional-horsepower gear motors; GEA-1771, Telechron-operated automatic timer.

Electric Equipment. Roller-Smith Co., 233 Broadway, New York City—Advance Price Sheet 3, Catalog 123—Leaflet describing a new split-core transformer for use with ammeters.

Electrical Equipment. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Publications as follows: L. 20537, Type G high-speed synchronous motors; L. 20580, resistance split-phase motors; L. 20584 splash- and drip-proof drives; C. 1962, 12 pages on condensing bleeder turbines.

Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Publications as follows: Bulletin 1469-C, 16 pages illustrating and describing Newhouse crushers; Bulletin 1474, 8 pages on this company's Aero-Vib screen; Bulletin 1475, 12 pages on this company's Style B centrifugal vibrating screen.

Equipment. J. H. Day Co., Cincinnati, Ohio—Bulletin 355—8 pages on this company's dispersers and emulsifiers; 4-page pamphlet on automatic packers made by this company.

Equipment. B. F. Goodrich Co., Akron, Ohio—Folder describing advantages of rubber industrial tires as compared with steel wheels in their effect on industrial plant floors.

Equipment. Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.—48-page souvenir booklet of this company's exhibit at A Century of Progress Exposition, Chicago.

Furnaces. The Whiting Corp., Harvey, Ill.—Catalog 215—48 pages on melting equipment for use in metallurgical industries. Covers also powdered coal equipment.

Instruments. Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.—Bulletin 255—6 pages on a thermal-conductivity combustible gas analyzer made by this company in portable and permanent-installation types.

Lighting. Electric Storage Battery Co., Allegheny Ave. and 19th St., Philadelphia, Pa.—6-page folder describing the "Keepalite" emergency lighting system for industrial plants.

Lubrication. Acheson Oildag Co., Port Huron, Mich.—Bulletin C 102—Deals with colloidal graphite as a lubricant for small mechanical devices.

Metals and Alloys. Driver Harris Co., Harrison, N. J.—60-page booklet with tables and engineering data covering the application of this company's alloys in electrical, mechanical and chemical uses; price $0.25.

Metals and Alloys. The Duriron Co., Dayton, Ohio—Price list 17—8 pages on standard Duriron equipment including valves, pipe, fittings, fans and pumps.

Metals and Alloys. Lebanon Steel Foundry, Lebanon, Pa.—8-page pamphlet, describing this company's line of casting steels including chromium and chromium-nickel steels.

Motors. Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.—Part 5A, Bulletin 167—6 pages illustrating and describing construction of this company's long-hour-duty split-phase motors.

Pulverizing. Raymond Bros. Impact Pulverizer Co., 1302 North Branch St., Chicago, Ill.—Folder briefly describing a Century of Progress in pulverizing.

Pumps. Morris Machine Works, Baldwinsville, N. Y.—Bulletin 149—16 pages with illustrations and engineering data on this company's side-suction pumps.

Pumps. Nash Engineering Co., South Norwalk, Conn.—Bulletin 217—35 pages with tabular data and descriptions of the various sorts of pump made by this company.

Pumps. Worthington Pump & Machinery Corp., Harrison, N. J.—Publications as follows: Bulletin D-111-S3A, general-service horizontal steam pumps; D-111-S4A, steam pumps for highly volatile liquids; Bulletin W-850-B32, 3, 4, 7, portable air compressors from 120 to 360 c.f.m. capacity; L-600-B3, 4 pages on refrigeration compressors.

Roll-Winders. Cameron Machine Co., Brooklyn, N. Y.—8 pages on the production of newsprint rolls with this company's equipment.

Screens. J. H. Day Co., 1144 Harrison Ave., Cincinnati, Ohio—4-page folder describing this company's ball-cleaned gyratory sifters.

Screens. Orville Simpson Co., 1230 Knowlton St., Cincinnati, Ohio—Pictorial folder, called Rotex Pictorial News, illustrating applications of this company's gyratory screens.

Valves. W. H. Nicholson & Co., Wilkes-Barre, Pa.—Bulletin 633—4 pages on this company's solenoid-operated valves.

Ventilation. Buffalo Forge Co., Buffalo, N. Y.—Bulletin 2904—4 pages on unit coolers; 475-C, 4 pages on small ventilating fans.

Water Treatment. D. W. Haering & Co., 3408 West Monroe St., Chicago, Ill.—16-page booklet on this company's methods of water treatment.

NEWS OF THE INDUSTRY

England plans large scale production of gasoline by the hydrogenation of coal. Chemical industry submits code. Prof. W. T. Read will again direct student courses at Chemical Exposition. Electrochemists arrange an International Convocation on Corrosion for their September meeting in Chicago and set aside day for celebrating Faraday centennial

Electrochemists Complete Plans for Chicago Meeting

FROM reservations already made a large attendance is in prospect for the meeting of The Electrochemical Society, Inc., which will be held in Chicago, Sept. 7-9. Convention headquarters will be in the Hotel Stevens and after registration on Thursday morning, Dr. F. N. Speller of Pittsburgh will open the International Convocation on Corrosion. The international aspect of this session may be inferred from a partial enumeration of the papers to be read.

A. W. Hothersall of London will discuss the "Adhesion of Electrodeposited Coatings to Steel." Karl Daeves of Dusseldorf, Germany, will emphasize the "Effect of Composition and Pre-Treatment of Steels Upon the Life of Protective Coatings." E. Herzog of Lille, France, will present his views on the "Value of Electrodeposits in Protecting Iron." S. C. Britton and Ulick R. Evans of Cambridge, England, will report on their scientific study of "Protective Painting," and Manfred Ragg of Hamburg, Germany, will advocate the "Use of Lead Pigments to Protect Iron and Steel." Oliver P. Watts of the University of Wisconsin will present the most modern interpretation of the "Theory of Corrosion." Among others to participate in this International Convocation on Corrosion are Lobry de Bruyn of Amsterdam, Holland and L. Hajda of Drátnova, Czechoslovakia.

On the evening of Sept. 7 an informal dinner dance will be held at the Hotel Stevens at which the Acheson medal will be presented to Dr. Colin G. Fink.

Friday, Sept. 8, has been designated "Faraday Day" and will be observed as a centennial celebration of the discoveries of Michael Faraday. The Illinois Building will be headquarters for that day and in the evening Dr. Robert S. Hutton who holds the Goldsmiths' Professorship in Metallurgy at Cambridge University will deliver an address on "Michael Faraday's Contributions to Electrochemistry."

Student Courses Arranged For Chemical Show

THE program of student courses at the Fourteenth Exposition of Chemical Industries in Grand Central Palace, New York, Dec. 4-9, will again be directed by W. T. Read, Dean of the School of Chemistry at Rutgers University.

To insure that the student courses be thoroughly practical, in line with the most advanced professional standards, a group of distinguished chemists and chemical engineers has been appointed to advise with the management of the exposition, and to assist Dean Read in planning the student program. This group, known as the Educational Committee of the Fourteenth Exposition, is constituted as follows: B. T. Brooks, C. R. Downs, P. C. Kingsbury—representing the American Institute of Chemical Engineers; Gerald L. Wendt, Ross A. Baker, and Neil E. Gordon—representing the American Chemical Society; M. L. Crossley—representing The American Institute of Chemists; and Reston Stevenson, representing the Electrochemical Society.

This year's program of student courses will be divided into sessions dealing with elementary chemical engineering, advanced chemical engineering, and industrial chemistry.

Process Equipment Makers Urged To Organize

LEADING manufacturers of chemical or process equipment are being urged to form a new trade association which will serve these companies in the preparation of a code of fair competition. The suggestion has been made that the new organization should join the Machinery and Allied Products Institute.

The latter, a federation of trade associations in the field indicated by its name, was organized at a meeting held in New York on June 23, attended by some 60 representatives of manufacturers of machinery and allied products. Its headquarters is at 221 North LaSalle St., Chicago, Ill. For information in regard to its activities, inquiries should be addressed to John W. O'Leary, president.

In the division of assignments among the deputy administrators of NRA, most of the machinery and equipment codes are to be heard by Malcolm Muir.

Rehearing Granted for duPont-Glidden Suit

SETTING up nine specific counts to substantiate the contention that the court had been led to wrong conclusions, The Glidden Co., through its counsel, petitioned the U. S. Circuit Court of Appeals for a rehearing of the duPont-Glidden suit involving the validity of Duco patents. Last month the Court of Appeals reversed the decision of the lower court which had ruled in favor of The Glidden Co. and held that the Duco patent granted to Edmund M. Flaherty was valid.

In response to the petition for a rehearing the appellate court has consented to review the case and it has been tentatively scheduled on the court docket for Sept. 10.

NEWS FROM ABROAD

By Special Correspondents of Chem. & Met. at London, Berlin and Paris

London

THE OUTSTANDING news of the month is the government announcement in regard to the hydrogenation of coal to produce gasoline, this large scale experiment being supported by a reduction of 4 pence per Imperial gallon in the tax. It is common knowledge that Imperial Chemical Industries, Ltd., has studied this question for years, are owners jointly with the Shell, I.G. and Standard Oil (N.J.) of the relative patents and have spent about $5,000,000 on a pilot plant.

In view of this government support, it has been decided to proceed with a plant of 100,000 tons annual capacity, which it is estimated will require a capital expenditure of $12,000,000, and also utilize existing plant of the value of about $7,000,000. This installation will use about 370,000 tons of coal per annum, gives temporary employment to 12,000 men and permanent employment to about 4,000 men, with useful repercussion in the coal mining industry and the iron and steel and chemical plant trades. Originally a plant of double the size was visualized, and the present project will be capable of supplying only about 3 per cent of the country's present requirements of gasoline. It is thought that with the promised rebate, a fair profit can be earned on capital, and if cost of production should be found capable of reduction, extension of this new industry may conceivably be practicable, but it seems unlikely that it can ever produce fuel oil on an economic basis.

The proposals have met with a good press and general support from those qualified technically and commercially, and moreover will stimulate at a very opportune moment further development in the low temperature carbonization field, and also the production of benzol by the high temperature process as practiced by utility gas undertakings and coke ovens. Imperial Chemical Industries is not likely to have a complete monopoly in the hydrogenation field, and it will be open to other firms with or without the experience available from the work done at the Government Fuel Research Board to consider entering this market, provided that the patent situation presents no serious obstacles. In particular, development in the hydrogenation of low temperature tar may at any time widen the field, but it is to be hoped that the very large available market will prevent a repetition of the experience of the synthetic fertilizer trade, and enable the pioneers to reap a just reward.

At the annual meeting of the Society of Chemical Industry many papers of unusual interest were presented and special reference might be made to that on the sulphur elimination plant installed at the Battersea Power Station in London, the total cost of which is estimated at about $1,200,000 and designed to handle the gases from 133 tons of coal per hour. The total cost of treatment, including capital charges of no less than 10 pence per ton, will be about 15 pence, or say 30 cents, per ton of coal. To transfer the plant fifteen or twenty miles down the river to avoid air pollution in the heart of the city would have involved an extra cost of about 5 shillings per ton of coal for transmission cost and about ten times the capital outlay, so that the net saving is 3 shillings and 9 pence per ton of coal, or about $900,000 per annum.

There seems to be considerable activity in the transparent paper field as regards extension in the manufacture of paper of the viscose type, and new installations for paper with a cellulose acetate base. The latter is more expensive and its market is therefore limited, so that new installations seem difficult to justify. On the other hand, a new type of acetate paper is about to be tried out, and it is claimed that its manufactured cost is low enough to compete with viscose paper, and moreover it is said to be resistant for an hour or longer to the action of boiling water without losing transparency.

Considerable progress has been made in the manufacture of champagne near London, the output for the current year exceeding 1,000,000 bottles. The product, which is manufactured from the juice of vintage champagne grapes, is sold under the name of Moussec, and its successful development is based upon a successful chemical engineering research by which the "must" after blending and purifying is evaporated to the consistency of cheese before despatch. The grape sugar content enables this product to be stored over long periods until required, and when redissolved in water before fermentation is found to have retained all the original characteristics of the "must." Moreover, when the champagne has been made in the normal way from the reconstituted "must," only about a year is required for settling out impurities sufficiently to make the champagne ready for consumption, whereas much longer is required otherwise.

As generally expected, Imperial Chemical Industries, Ltd., has made an offer to purchase the issued share capital of the Chemical & Metallurgical Corp., Ltd., which has been competing in the sulphuric and hydrochloric acid market, and to which reference has previously been made in these columns. The manufacture of edible gelatin, which was recently started by the company, is to be continued as a separate organization.

Paris

AN IMPORTANT event for the metallurgical industry has been the reorganization of the international steel cartel, which took place in Luxembourg on May 5, and which includes the following countries: France, Germany, including the Saar District, Belgium, and Luxembourg. This cartel has fixed the following export quota: Belgium, 29 per cent; Germany and the Saar District, 29; France, 21; and Luxembourg, 21 per cent. Production for domestic requirements has been regulated by agreements among the producers.

The serious effect of the depression on the metallurgical industry is easily seen from the fact that the 1932 steel production was only 58 per cent of the output in 1929; a slight improvement is now noticeable. The monthly production of pig iron, which was 452,000 tons last February, reached 525,000 tons in March, 516,000 in April, and 554,000 tons in May, the highest figure since November, 1931.

It is also evident that coal production has likewise seen the low mark. Production fell from 54,000,000 tons in 1930 to 50,000,000 tons in 1931 and to 46,000,000 tons in 1932; imports likewise fell from 23,000,000 tons in 1931 to 18,000,000 in 1932, corresponding to a value of 2,000,000,000 Fr. This decrease in coal output was not entirely due to the depression, but also to the steadily increasing competition from liquid fuels, such as fuel oil and gasoline and to increasing electrification. Recently the hydroelectric plants at Kenbs on the Rhone and at Truyere in l'Aveyron have been put in operation.

Here it should be observed that the coal producers are more and more getting into position to utilize coal as raw material for production of chemicals, such as ammonia and ammonium salts; organic compounds, such as formalde-

hyde, methanol, ethyl alcohol, ether, benzene, phenol, and many others.

A celebration was recently held to commemorate the fifty-year anniversary of the School of Industrial Chemistry and Physics, from which about 1,000 chemists and 500 physicists have been graduated during the time of its existence. At this occasion Georges Claude, who is a graduate from this school, gave some details concerning a new method of illumination, a combination of the red neon light with the blue mercury light, which already has found some application in illumination of shops and store rooms.

The technical difficulty which had to be solved was the combining of the neon tubes, which have high tension and low current, with tubes of low tension and high current. In collaboration with his cousin, Andre Claude, he solved this problem by using regenerative cathodes, consisting of a liquid mass, such as fused potassium, connected with the distributing pole, and protected anodes consisting of very hot metal surfaces incapable of occluding the gas.

Another solution has been anticipated, the use of xenon, associated with neon, and mercury, which produces a beautiful white light.

Berlin

OF important technical methods discussed at the Wurzburg meeting of the German Chemical Society may be mentioned the following: A process of extracting rubidium and the salts of this metal from carnallite by methods of fractional crystallization based on studies of the phase rule has been developed by Dr. J. D'Ans, of Berlin. Three fractions are obtained by this method, a chloride low in RbCl, a mother liquor, and a carnallite enriched in RbCl, which may be converted into a 100 per cent rubidium carnallite by further crystallization. In order that the process may be worked successfully the natural carnallite should first be freed from its content of 0.04 per cent ammonium chloride. The potash industry has again taken up production of rubidium by this process, which has the advantage that hardly any chemicals are required.

Production of Fliesskohle (fluid coal) from lignite was discussed by Dr. G. Benthen of Freiberg. Fliesskohle is a mixture of coal and oil, from which the coal does not settle, or separates only with greatest difficulty; it is expected to effect a replacement of foreign fuel oil with domestic coal. In the production of this material from ordinary coal, which must first be ground exceedingly fine in colloid mills and then dispersed in various types of oil with addition of protective colloids, the cost of the fine grinding is very high. Therefore, more active humic acids of lignite are substituted for the ulmins of coal. The lignite may be used without such fine grinding; emulsification in the oil is carried out with addition of some lignite creosote, whereby a mixture with 30 per cent coal is obtained, whereas a mixture with 40 per cent is possible with hard coal. Addition of alkali has a further peptisizing effect on the coal by combining with the creosote to form soaps which act as protective colloids.

Professor Galle, Brun, has accomplished hydrogenation of petroleum fractions with good results by producing finely divided aluminum chloride and hydrogen directly in the petroleum by action of HCl = gas and aluminum activated with mercury chlorides. A yield of an equal volume of gasoline of saturated character is obtained at 180 deg. C. without pressure. Technical application of this interesting process appears possible when it becomes possible to reduce the saturated characteristics of the gasoline by chemical means or by proper mixing.

Dr. Ederer, Frankfurt A.M. discussed a new method for dewatering alcohol. In order to use alcohol as motor fuel mixed with gasoline or benzene, the 90-96 per cent alcohol is treated in a Raschig ring tower in counter-current with low fusing salts such as sodium or potassium acetate dissolved in absolute alcohol. The salt takes up the water and collects at the lower end of the tower. The alcohol is conducted back to the system through a cooler, and the salt solution is collected and evaporated and dried in a steam heater pan at 200-260 deg. C., whereupon it flows to a mixer where it is again dissolved in absolute alcohol as returned to the tower. The process, which is owned by Holzindustrie A.G. is not only used for production of alcohol for motor fuel, but also for alcohol used for pharmaceutical purposes, for perfume, and for beverages.

CALENDAR

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, fall meeting, Roanoke, Va., Dec. 6-8.

ELECTROCHEMICAL SOCIETY, fall meeting, Chicago, Ill., Sept. 7, 8, 9.

AMERICAN CHEMICAL SOCIETY, 86th meeting, Chicago, Ill., week of Sept. 11, 1933.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY, fall meeting, Appleton, Wis., Sept. 26-28.

NATIONAL METAL CONGRESS AND EXPOSITION, Detroit, Mich., Oct. 2-6, 1933.

AMERICAN PETROLEUM INSTITUTE, Chicago, Ill., Oct. 24-26.

FEDERATION OF PAINT & VARNISH PRODUCTION CLUBS, convention and paint show, Chicago, Ill., Oct. 26-20.

FOURTEENTH EXPOSITION OF CHEMICAL INDUSTRIES, New York, week of Dec. 4-9, 1933.

New Plant for Bromine Recovery From the Sea

THE first plant to be constructed on shore for the recovery of bromine from the sea is now being built at Kure Beach about 20 miles south of Wilmington, N. C. The plant will be operated by the Ethyl-Dow Chemical Co., a new concern formed by the Ethyl Gasoline Corp. and the Dow Chemical Co.

The output will be utilized entirely by the Ethyl Gasoline Corp. as a constituent of Ethyl fluid. The enterprise, however, will result in a tremendous increase in the potential production of bromides in the United States, affecting not only industry and the arts but also the national defense as bromine is an essential element of certain tear gases used in warfare.

The Ethyl-Dow plant is being built in units, each having a monthly capacity of 250,000 lb. of bromides. To produce 500,000 lb. of bromine a month, it is necessary to process the seawater at the rate of 26,000 gal. per minute for twenty-four hours a day. The latest process developed by chemists and engineers of the Dow company involves treating the seawater with enough chlorine to convert the bromides in the water to free bromine. This bromine is blown out of the seawater by a current of air. The air containing the bromine is then brought into contact with soda solution which absorbs the bromine, forming a concentrated solution of bromide-bromate.

Research on Phosphates at Mellon Institute

The Buromin Company of Pittsburgh, Pa., which has made wide application of molecularly dehydrated phosphates of the alkali metals in water conditioning and washing, has founded an Industrial Fellowship at Mellon Institute for the purpose of investigating broadly the properties of these chemicals and of extending their uses in the industries, in medicine, and in the home. Special attention will be accorded to "Calgon," which is essentially sodium metaphosphate. Dr. Bernard H. Gilmore, who has been selected as the incumbent of this Fellowship, started his research program on June 15.

NEWS FROM WASHINGTON

By PAUL WOOTON

Washington Correspondent of Chem. & Met.

THE COGS of the whirring NRA machine began to enmesh and the clatter of confusion gave place to a semblance of regularity and efficiency as the big engine of the recovery plan completed its ninth week of official existence. A definite code procedure has been set up; codes go to a control board, pass through a code analysis section and a legal study before they are taken up even for preliminary hearings. The place of the advisory boards has been set; Dr. Leo Wolman, chairman of the labor advisory board, has become one of the powerful figures in the NRA; the industrial advisory board has narrowed itself down to a group of men who are not only outstanding leaders in industry but who can and do come to Washington in shifts to work, to be on the job, and at the call of the Administrator; the Consumers Advisory Board alone has not found its place.

There has developed a sound effective procedure for the determination of problems of industry trade practice, the Code Authority. Every code, past and future, is to set up this Code Authority.

The Code Authority is to be not only the judge, jury and attorney for all matters of fair practice in the industry, subject only to the approval of the NRA through the deputy administrator in charge of the industry, but it is also the police force for the enforcement of the provisions of the code. Under the newly established procedure, all complaints of violations of a code come to the Code Authority, it seeks to settle the matter with a warning and if that does not work, presents a full case to NRA, which again seeks to settle the matter amicably and, that failing, turns the question over to the Federal Trade Commission, which prepares the case, turns it over to the Department of Justice and the wheels of law, with penalties of $500 fine and six months in jail for each offence (and every day of violation is a new offence) do the rest.

Lime

The code of the lime industry, the first of the continuous process industries to be heard before NRA, was discussed before Malcolm Muir, who is deputy administrator for NRA for the construction industry. The code was put through its hearing in one day (Aug. 8). While final determination of the provisions will not become known until the code is presented to President Roosevelt for approval, it was agreed tentatively by labor and employers that the code's proposed 40 hour week should be retained (although NRA's statistical data show that a 37.2 hour week would be required to put the full employment of the industry in 1929 back to work). Wages were raised in the agreement made by a labor-industry committee during the hearing the code's from 25c. per hour to 30c. for the South and from the code's 35c. per hour for the North to 37½c., thus slightly reducing the proposed 10c. differential, which Deputy Administrator Muir had pointed out was the greatest differential offered in any code so far heard. A spirited defense of the 25c. rate for the South was made on the ground of lower living costs and also that under the code as drawn employment was increased 20.7 per cent and purchasing power about 23 per cent.

There was some controversy over the division of the wage districts, the Frederick, Md., companies holding that the West Virginia fields, as their chief competitor, should be included in the Northern district. This will be decided upon later on the basis of the evidence.

Gas

The gas operating utility industry proposes to establish minimum wages ranging from $12 weekly in towns of less than 2,500 population to $15 weekly in cities of more than 500,000. Average hours per week in any 90-day period may not exceed 40, except for highly trained employees such as load dispatchers, production and distribution operators and emergency service, maintenance and repair crews whose weekly average may not exceed 48 hours. The American Gas Association has requested member companies to train additional employees as rapidly as consistent with rendition of safe and continuous service so that as large a number of employees as possible may be placed on the 40-hour basis.

Salt

A complete code for the salt producing industry as submitted to NRA proposes a minimum wage of 20c. an hour for female and 25c. for male labor in Texas and Louisiana and 30c. and 35c. in the north. Forty-eight hours is established as the average maximum work week during any 6-month period in the south. The maximum for employees engaged in processing or manufacturing operations in the north is 42 hours a week; for all other classes of labor, a maximum average of 40 hours in any 6-month period.

The code continues the practice whereby each producer in his respective field publishes his prices, with 10 days' notice of changes to all other producers. The code prohibits the sale of any grade of salt at a net price less than a producer's current cost of production or the current cost of the lowest-cost producer in the field. The code committee may require manufacturers to furnish complete cost data to the end that a uniform system of cost accounting may be adopted for the industry. Storage of salt in customers warehouses and numerous other unfair practices endemic in this and other industries are condemned by the code.

Fertilizers

The code submitted to NRA by the National Fertilizer Association covers primarily the mixed fertilizer and superphosphate industries in all their relationships but other fertilizer materials are dealt with to the extent that their distribution affects the production industry. It is the hope of the code committee that the draft will be satisfactory to other closely associated groups such as njtrogen, potash, rock phosphate, and sulphur industries.

The provisions on hours and rates of pay provoked the most controversy. A maximum 40-hour week and 8-hour day is proposed, with an exception for continuous operation processes in which the maximum week may be 48 hours. The minimum rate of pay for northern and midwestern states is 35c. an hour; in the south 25c. and in the far west 40c. with 1½ times the normal rate for overtime. The new minimum rates average 60 per cent over prevailing rates as shown by a survey made by the association within the past few weeks and will, it is claimed, restore 1929 purchasing power to workers in the industry. Permission has been requested to substitute the labor provisions of the code for the appropriation sections of the President's reemployment agreement so that the industry can participate immediately in the recovery program and capture the blue eagle.

If approved by NRA, the industry's "recovery committee" would be empowered to issue rules for the purpose of controlling and regulating production and to this end may collect statistics regarding production of mixed fertilizer, superphosphate or other fertilizer material in order to determine at any time whether there is overproduction. Sales below reasonable cost, plus reasonable profit would be prohibited; "reasonable cost" is defined as the fair average cost determined by zones in accordance with uniform rules to be prescribed by the committee.

Under the open-price basis of selling that is proposed, each producer would file his schedule with the association and with his competitors in the territory. No new schedule would become effective until 10 days after filing and prices may be changed only as a result of legitimate changes in costs of materials or of manufacturing costs. Sales must be made on the basis of uniform forms of contract to be prescribed by the recovery committee for the several trade zones.

One of the most significant provisions of the code provides for a voluntary plan for

reducing the number of grades offered for sale. If this provision is adopted, the producers in each state or zone would select, in conference with state or federal agricultural officials, a list of grades to be registered and sold, after which the sale of other grades would be considered an unfair trade practice. The sale of special formulas or special ingredients in standard formulas would be permitted when made on bona fide orders if adequate additional charge is made for mixing or for special ingredients. Sale by any producer of two grades for lawns and gardens in packages not to exceed 100 lbs. would be prohibited.

No traveling salesmen would be employed on a commission basis except in Florida and employment of an unreasonable number of salesmen by any company would be prohibited. Sales to cooperative associations would be permitted but such associations would be obliged to maintain the producer's schedule of prices. Sales to dealers and consumers through brokers would be prohibited. No importer would be permitted to sell at prices lower than those charged by domestic producers in the same zone.

Prohibited practices include truck service without adequate charge, selling or consigning materials at reduced prices to induce purchase of mixed fertilizer, superphosphate or other material, guaranteeing prices against decline. The recovery committee would be authorized to prescribe regulations requiring reports from producers concerning labor, prices, marketing practices, and other information necessary for enforcing the code. Provision is made for collecting damages from firms selling below cost and distributing such funds among others. Cost of administering the code would be borne by all producers, irrespective of membership in the association.

Rayon

NRA has approved a modified reemployment agreement for the rayon and synthetic yarn producing industry establishing a 40-hour maximum work week with a minimum wage of $13 a week. The code submitted by the industry provides that employees shall receive the same wage for 40 hours as for 48 hours, as of May 1, 1933. Because the manufacture of synthetic yarns is a continuous process, the chemical and textile departments being in balance, the code recites that any limitation on machine hours cannot economically apply. The industry also represents that it is not "over-capacitated," consumption in 1932 representing 83 per cent of capacity. NRA was also informed that any necessary reduction below capacity rate must be made by complete shutdown of a portion of the equipment rather than by curtailing hours of operation.

Paint, Varnish and Lacquer

A novel feature of paint, varnish and lacquer industry's code is the specific provision made for partially incapacitated old employees. Each manufacturer will be expected to take care of a small number of such employees who have been in their employ for at least 10 years by giving them light work for not less than 30c. an hour. This provision has been accepted by NRA together with the conventional provisions of the code governing wages and hours of labor as a modification of the President's reemployment agreement in this industry.

The code establishes 40 hours as the maximum week for factory and mechanical labor, except that the maximum may be 48 hours in any 6 weeks within a period of 6 months. The maximum for accounting, clerical, office and delivery employees is 1088 hours in any 26-week period. This is equivalent to a maximum week of 40 hours for 20 weeks and of 48 hours for 6 weeks within a 6-month period. The minimum wage provisions require employers to increase the wages of accounting, clerical, office and delivery employees in towns of less than 2500 by 20 per cent on the condition that this shall not require wages in excess of $12 a week; in cities of 2500 to 250,000 the minimum wage is $14; in cities between 250,000 and 500,000, $14.50 and in cities over 500,000, $15. The minimum wage rates of factory and mechanical employees are 40 cents for adult males and 35 cents for female employees and male employees under 18 years, such minima to apply regardless of whether the employee is on a time rate or piece work basis.

The code of the paint, varnish and lacquer industry includes manufacturing restrictions eliminating containers of certain sizes and types and limiting the number of tints or shades. Selling below cost is prohibited and the price of all products marketed in other than one gallon cans must be adjusted in accordance with a standard uniform package differential which is made a part of the code. Prohibited as unfair practices are misbranding and false advertising, gifts to customers' employees, exchange of goods for those of another manufacturer, guarantees against price decline except in the case of trade sales spring stock orders and trade sales initial stock orders, time guarantees on the life or service of products, supplying trade sales accounts on consignment, free deals, including sale of alcohol, turpentine, linseed oil, or other products not manufactured by the industry at prices less than the resale market price, inducing breach of contract, disparagement of competitors, underselling claims, and enticing employees.

Datings on orders to establish trade sales accounts are limited to datings on spring stock orders shipped at the manufacturer's convenience after Dec. 1 (Oct. 1 if shipment is made by water) with an April 1 dating and regular terms; one order to an account. The maximum dating on trade sales stock orders to new accounts is limited to 4 months from date of shipment and with standard terms. An anticipated discount of one-half of 1 per cent per month is permitted. Standard terms of cash discount are prescribed by the code. No merchandise may be returned without first securing the consent of the manufacturer. Administration of the code is placed in the hands of a recovery board composed of 8 members of the general code committee, 20 members representing commodity groups and 20 members representing communities.

Zinc

A modified agreement for the zinc industry accepted by NRA pending approval of a code fixes the following minimum rates of pay in the mining division: 35c. an hour in the eastern and northwestern districts; 30c. an hour in southern, Mississippi Valley and southwestern districts. In the prime western smelting division the minimum is 30c. for unskilled labor and at the rate of $2.75 per shift of not more than 8 hours for all other labor. In the high grade zinc division the minimum is 39c. and in the secondary division 35c. except for cleaners and outside labor, fixed at 30c. Minimum rates in the rolled zinc division are the same as in the secondary division. In zinc oxide and lithopone divisions the minimum wage is 35c. and the same in the sulphuric acid division, except for 30c. to cleaners and outside labor.

Petroleum

Pending agreement on price-fixing and other controversial provisions, the petroleum industry has been permitted by NRA to substitute for the President's reemployment agreement, the minimum rates of wage and maximum hours prescribed by the code. In drilling, production, refinery and pipe-line operations, a maximum week of 40 hours is fixed for clerical employees, and 36 hours for all other employees, with a maximum of 40 hours per week for any 6 weeks within any 26 week period, but not more than 8 hours in any one day. Minimum hourly wage rates range from 45c. to 52c. according to geographic division.

Linseed Oil

In linseed oil manufacture 40 hours per week, or 160 hours for a 4-week period, has been accepted by NRA as a substitute for the president's reemployment agreement.

Many of the chemical commodity codes may eventually evolve as supplements to the code drafted by the Chemical Alliance. This procedure may apply with reference to alcohol, solvents, chlorine and other sub-divisions of the industry. The Wood Chemical Institute filed a code prior to submission of the general code for chemical industry but may subscribe to the latter if it is acceptable to a majority of its members. Recognition of quality standards for wood chemicals and marketing rules intended to stabilize the prices of both charcoal and chemicals are proposed.

Virtually all industries which have not brought in their codes are waiting on some definite policy of classification, where the bolt and nut people belong, for instance, in hardware or machinery. A proper industrial study announcing the tentative basis of the whole industrial structure is a vital necessity and becomes more important daily.

NAMES IN THE NEWS

R. F. STEWART of the Dorr-Oliver, Ltd., London, is visiting the New York office of the parent company.

JAMES V. SLADE, after many years' service with the Dorr Co., resigned July 1. He has joined the production department of the General Foods Corp.

OLIVER E. BUCKLEY succeeds the late Dr. H. D. Arnold as director of research for the Bell Telephone Laboratories, New York City.

H. W. How has joined the staff of the process equipment department of Blaw-Knox Co., Pittsburgh, Pa. He will become actively associated with the further development of the welded pressure equipment.

H. O. CASTER, of Henry L. Doherty & Co., has been nominated president of the American Gas Association for 1933-34. P. S. Young of the Public Service Electric and Gas Co., of Newark, N. J., received the nomination for vice-president of the association.

JOHN J. WATSON, president of the International Agricultural Corp., was recently elected president of the National Fertilizer Association; C. T. Melvin, of the Gulf Fertilizer Co., vice-president; and Charles J. Brand, executive secretary and treasurer.

CHARLES H. MACDOWELL, for many years president of the Armour Fertilizer Work, has been appointed to assist in the new fertilizer recovery work in connection with the National Recovery Administration.

H. B. VOLLRATH, for 14 years sales engineer for Baker Perkins Co., resigned July 31 to accept a position on the engineering staff of Sylvania Industrial Corp., Fredericksburg, Va.

E. W. LIEBEN, formerly in the research division of the General Chemical Co., has accepted a position in the acid department of the Monsanto Chemical Co., St. Louis, Mo.

GEORGE ROMMEL, of Savannah, Ga., has been appointed by Dr. Morgan a research expert on decentralization of industry for the Muscle Shoals development.

WALTER A. POLAKOV has been appointed chief engineer of Muscle Shoals.

R. S. RICHARDSON, who is now president of the Chemical Engineering Corp., sailed July 27 for France.

J. RUSSELL PORTER has been made manager of potash sales for the American Potash and Chemical Corp., with headquarters in New York City. For many years he was president of the Porter Fertilizer Works of Atlanta. He has served the industry as president of the Southern Fertilizer Association from 1920 to 1923.

FRANK A. HOWARD has been appointed to the position of president of the Standard Oil Development Co. and Hydro Engineering and Chemical Co. He retains the presidency of Hydro Patents Co. and Standard I. G. Co.

FRANK A. HOWARD

E. M. CLARK

E. M. CLARK has retired as a director and vice-president of the Standard Oil Co. of New Jersey. In 1927 he became head of the Standard Oil Development Co., and three years later was elected a vice-president of the New Jersey company. Mr. Clark was associated with Dr. Wm. M. Burton in the development of the first successful cracking process.

R. T. HASLAM, who has been vice-president of the Standard Oil Development Co. in charge of research and development, becomes senior vice-president and assumes charge of operations for the company.

R. P. RUSSELL, general manager of Hydro Engineering and Chemical Co. and of the development division of the Standard Oil Development Co., takes over additional supervision of all general technical activities not hitherto consolidated.

N. E. LOOMIS becomes assistant to the vice-president while retaining his present post as manager of the technical service division of the Standard Oil Co. of New Jersey (Del.)

C. O. JOHNS has retired from the Standard Oil Co. In 1920 while with the U. S. Bureau of Chemistry he was invited to become director of research in the development department of the New Jersey company. When the development company was formed in 1929 Dr. Johns was made a director and member of the executive committee.

C. H. HAUPT, now that he has retired, can look back upon the visible results of his 33 years with the Standard Oil Co. of New Jersey. In 1913 he was made chief engineer, and four years later a member of the manufacturing committee. With the formation of the Development company in January, 1928, the general engineering department came under its jurisdiction and Mr. Haupt was made a vice-president and director. Later he was appointed to similar responsibilities with the newly created Hydro Engineering and Chemical Co.

W. E. SOHL, who received his Ph.D. degree from the University of Illinois in June, has accepted a position as research chemist in the ammonia department of the E. I. du Pont de Nemours & Co. at Wilmington, Del.

H. A. SMITH has been appointed a National Research Fellow and will work on metallurgical problems at Carnegie Institute of Technology.

B. S. HOPKINS was elected president of the Illinois Academy of Science at the recent annual meeting in East St. Louis.

HARRY E. KAISER has resigned the directorate of the experimental station of the Hercules Powder Co., Wilmington, Del. Mr. Kaiser is returning to California where his presence is necessitated by business and family interests. He has been connected with Hercules since 1918 and has been director of experimental work for 11 years. During the period important research developments in the explosive, naval stores, cellulose and cellulose products fields have been made.

O. A. PICKETT, for a number of years in charge of the physical chemistry division of the Hercules Experimental Station, has been appointed acting director.

J. C. FOX, chief chemist and metallurgist of the Doehler Die Casting Co., has transferred his office to the Toledo, Ohio, plant of the company. He will continue in the same duties as formerly.

R. W. MCCORKINDALE has retired from the Parsons Paper Co., which he served as superintendent for the last ten years.

HARRY J. BUNCKE has joined the Oxford Paper Co. as chief engineer of the Rumford, Me., plant. He comes to Rumford from the Abitibi Power and Paper Co.'s Toronto office. F. J. Latham, formerly chief engineer of the Oxford plant will serve the company as consulting engineer.

FRANK F. LINDSTAEDT, who for the past seven years has been director of research for the Colloidal Products Co. and the Hercules Glue Co. of San Francisco, has resigned his positions to establish a practice as consulting chemist. He will specialize in insecticidal and colloidal chemistry.

HENRY L. BEAKES has joined the technical staff of the Kentucky Color and Chemical Co., Louisville. Previously he had served the Devoe and Reynolds Co. as technical director of its industrial laboratory at Louisville.

L. R. BLACKHURST has been appointed general manager of the Pyralin products department of the E. I. du Pont de Nemours & Co. He has succeeded D. F. Carpenter who has been transferred to the Remington Arms Co. H. R. Dorr has been appointed director of manufacture of the Pyralin products department.

H. E. SIMMONS is being congratulated on having been chosen president of Akron University. In 1908 he graduated from Buchtel College, as the university was then named, and then attended the University of Pennsylvania where he served as instructor. He returned to his Alma Mater in 1910 to become professor of chemistry.

ROBERT C. KINTNER, formerly of the department of chemical engineering of Ohio State University, has accepted the position of assistant professor of chemical engineering at Bucknell University, Lewisburg, Pa.

S. C. OGBURN, JR., formerly head of the department of chemical engineering at Bucknell University, has been appointed chairman, division of engineering, at that institution.

C. W. BETZ on July 1 was appointed chemist for the state of California. He is stationed at the Homestead Plant of the Carnegie Steel Co. inspecting steel for use in building the San Francisco-Oakland Bay Bridge. Formerly Mr. Betz was chief chemist for the county of Allegheny, Pa.

W. LASH MILLER of Toronto, Canada, has been chosen vice-president of the Royal Society of Canada.

ROBERT S. HUTTON, who holds the Goldsmith's professorship in metallurgy at the University of Cambridge, England, will visit this country in September. Dr. Hutton will be the guest of honor of the Electrochemical Society and will deliver the Faraday address at the Chicago meeting on Sept. 8.

OBITUARY

GEORGE MELVILLE LYNN, chief chemist in charge of the research department of the Columbia Chemical Co., subsidiary of the Pittsburgh Plate Glass Co., died July 15, 1933. He was 36 years of age. Death was due to injuries received in an automobile accident.

He graduated from Kansas University in 1922 with a Master's degree in chemical engineering, and then accepted a fellowship from the General Electric Co. to Yale University, from which he received a higher degree in 1925. After teaching at the University of Pittsburgh and serving as chemist in the Pittsburgh Station of the Bureau of Mines, he entered the services of the Columbia Chemical Co.

D. FRANK FOOKS died on June 4 at his home in Snow Hill, Md. He assisted in the organization of the Worcester Fertilizer Co. of Snow Hill and for many years has served as an officer and a member of the board of the company.

FRANCIS J. FUCHS, head of the chemistry department of St. John's University of Brooklyn, N. Y., died recently at his home. He was 44 years of age.

JAMES A. SHEPARD, vice-president of the Shepard Niles Crane and Hoist Corp., died June 10 at his summer home on Kayutah Lake in New York State.

PHILIP L. MARSTON, chief chemist of the Richfield Oil Co., of Long Beach, Calif., died June 10 at his home of cerebral hemorrhage.

GEORGE G. ROBERTS died May 23 at Moundsville, W. Va. He was 68 years old and had been in ill health for the last five years. Mr. Roberts served as chemist for the Bureau of Standards and was a member of President Hoover's Research Bureau.

WILLIAM J. STILES, retired general superintendent of the Standard Paper Manufacturing Co., died on July 14, 1933, at St. Luke's Hospital in Richmond, Va. He was 77 years old. He had been a superintendent for the Standard company for 32 years.

WILLIAM F. HAZEL, general superintendent of the Glens Falls division of the International Paper Co., died in Glens Falls July 16 after undergoing an operation. He was 55 years old.

BYRD WALKER, formerly head of the White Tar Co. of Kearny, N. J., died in Newark on July 25. He was 65 years old.

ROBERT R. RUST, formerly president of the Dry Ice Corp., New York City, died in New York on July 23. He was 54 years of age.

JOSEPH KENTSMITH, consulting metallurgist for the Climax Molybdenum Co., Battle Creek, Mich., died July 8. He participated in the development of vanadium steel and while in England he engaged in research work on special alloys for the British government.

FRANK W. PEEK, JR., chief engineer of the Pittsfield, Mass., works of the General Electric Co. and one of the company's specialists in high-voltage work, was killed July 26 when his automobile was struck by a train near Gascones, on the Gaspe Peninsula of Canada.

JAMES B. PRATT, chief chemist for the Southern Cotton Oil Co. in Columbia, S. C., died on July 23. He was 48 years old.

CHRISTIAN F. STAHL, for many years a chemist for the A. B. Hoffmann & Sons, Lynn, Mass., died July 18. Mr. Stahl was 70 years old.

CHEMICAL ECONOMICS

Manufacturing operations at chemical plants continued along progressive lines throughout July. Reductions in production schedules in some lines were more than offset by increased outputs in others and the industry as a whole reported an advance of more than 3½ per cent over the rate established in June.

DELIVERIES of chemicals to the various industries were reported to be large in the last month and most recent indexes indicate that production schedules at chemical plants have been steadily advanced in recent months with the July rate surpassing that of any of the preceding months of the year. In fact the July rate appears to be very close to that reported for June, 1930.

Figured from the comparative use of electrical energy, the index for production of chemicals has risen from 104.0 for April to 130.4 for July. Enlargement of activities at producing plants is pretty much in line with the reported positions of large consumers and apparently the larger output of chemicals has not had the result of piling up surplus stocks.

The gain in production in July was less general than in June as different branches of the industry reported some recession from the June rate while others increased the July rate over June in about the same proportion as they had increased the June rate over May.

According to the Department of Commerce, industrial activity in July exceeded the high rate of June despite a slight downturn toward the end of the month. Output in July, the survey said, would show a further increase over June, when industrial production was at the highest point since the middle of 1930 and was at 89 per cent of the 1923-25 average.

The survey again warned, however, that indices of distribution indicate a continued lag in consumer purchases, a discrepancy that is expected to be corrected through the NRA agreements to bolster wages and employment.

Employment opportunities were enlarged in June and there was a further estimated reduction of 500,000 in the number of unemployed. Pay rolls increased during that month more rapidly than did employment.

Business activity expanded further between mid-June and mid-July and additional gains in employment and pay rolls were expected for the current month.

With data for the first half of this year available for many industries, it is possible to form a fairly accurate idea regarding the extent of chemical consumption as compared with that for the corresponding period of last year. The accompanying table gives data for production of some chemicals and for production of commodities into which chemicals enter.

The totals for the first six months of 1933 are also given so as to offer a comparison between the first and second quarters of the year. Reports of increased activities from March forward have been common and the official figures are tabulated so that the gain in second quarter activities may be measured in a more or less definite way.

Comparing the figures for the first and second quarters of this year, the figures show marked gains in the second quarter in the textile, automotive, plate glass, and rubber industries. The fertilizer trade was less active in the second quarter but this may be attributed to seasonal influences with the decline in the second quarter much less than in the corresponding period of last year.

Relating the totals to the first half of 1932 and 1933 it is found that in some cases the high rate of operations in the second quarter gave a six-months total in excess of that reported for Jan.-June 1932. In other words, consumption of chemicals in the first half of this year exceeded that for the comparable period last year in the automotive, textile, plate glass, and fertilizer trades.

The Bureau of Mines estimates that domestic production of benzol reached a total of 24,834,424 gal. in the first six months of this year which compares with 26,253,000 gal. in the corresponding period of 1932. The estimate is based on production of coke at byproduct ovens which are known to recover benzol.

Factory production of fats and oils during the second quarter included 432,308,377 lb. of vegetable oils, 6,601,527 lb. of fish oils, 641,743,703 lb. of animal fats and 89,974,152 lb. of greases, a total of 1,170,627,758 lb., according to figures made public on Aug. 9 by the Census Bureau.

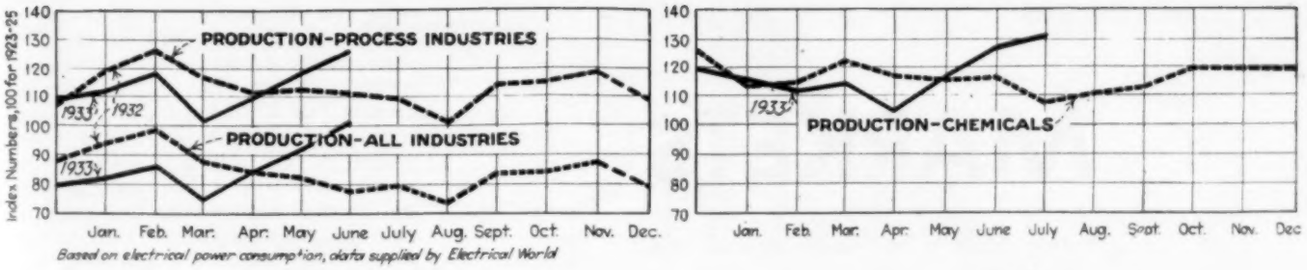
Production of refined oils during the quarter, the report showed, included 275,634,506 lb. of cottonseed, 68,388,869 lb. of coconut, 3,213,353 lb. of peanut, 35,974,046 lb. of corn, 3,036,735 lb. of soybean and 3,887,850 lb. of palm kernel.

Index numbers used on the graph on the following page are as follows:

	June
Chemicals	130.4
Glass containers	97.6
Petroleum refined	100.1
Cotton consumed	153.7
Byproduct coke	82.8
Explosives	67.3
Rubber reclaimed	96.9
Plate glass	131.1
Sulphuric acid	45.2

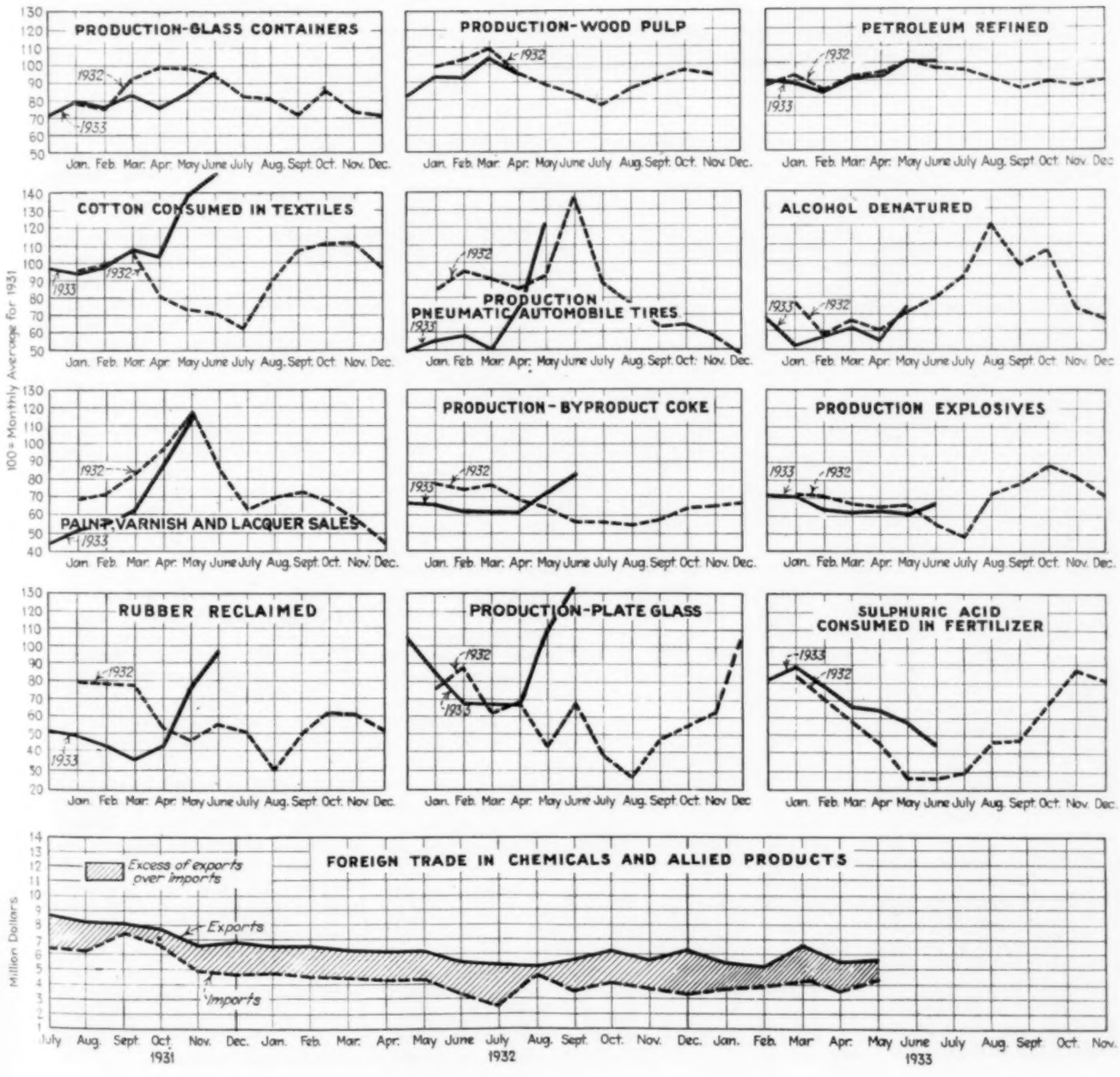
	First Quarter 1933	Second Quarter 1933	Per Cent of Gain Second Quarter	First Half 1932	First Half 1933	Per Cent of Gain in 1933
Automobiles, No.	354,818	652,292	83.8	871,448	1,007,110	15.6
Byproduct coke, 1,000 tons	5,090	5,818	14.3	11,349	10,908	3.9*
Cotton consumed, 1,000 bales	1,407	1,788	27.0	2,396	3,195	33.3
Explosives, 1,000 lb.	49,589	49,057	1.1*	101,066	98,646	2.4*
Glass containers, 1,000 gr.	4,925	5,268	6.9	11,039	10,193	7.7*
Plate glass, 1,000 sq. ft.	16,024	22,101	37.9	29,292	38,125	30.2
Acetate of lime, 1,000 lb.	12,282	7,013	42.9*	18,963	19,295	1.8
Methanol, crude, 1,000 gal.	837	538	35.7*	1,391	1,375	1.1*
Methanol, refined, 1,000 gal.	407	276	32.2*	678	684	0.9
Methanol, synthetic, 1,000 gal.	855	1,350	57.9	3,603	2,206	38.8*
Rubber reclaimed, tons	12,903	22,160	71.8	39,946	35,063	12.2*
Pneumatic tires, 1,000	5,307	11,530	117.3	19,188	16,837	12.3*
Sulphuric acid produced by fertilizer trade, tons	293,772	240,051	18.3*	468,186	533,823	14.0
Rosin, wood, bbl.	83,368	91,134	9.3	155,912	174,502	11.9
Turpentine, wood, bbl.	13,405	14,373	6.5	25,469	27,778	9.1

*Per cent of decline.



Based on electrical power consumption, data supplied by Electrical World

TRENDS OF PRODUCTION AND CONSUMPTION


100 = Monthly Average for 1931
PRODUCTION-GLASS CONTAINERS
PRODUCTION-WOOD PULP
PETROLEUM REFINED
COTTON CONSUMED IN TEXTILES
PRODUCTION PNEUMATIC AUTOMOBILE TIRES
ALCOHOL DENATURED
PAINT, VARNISH AND LACQUER SALES
PRODUCTION-BYPRODUCT COKE
PRODUCTION EXPLOSIVES
RUBBER RECLAIMED
PRODUCTION-PLATE GLASS
SULPHURIC ACID CONSUMED IN FERTILIZER
1932
1933
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
Million Dollars
FOREIGN TRADE IN CHEMICALS AND ALLIED PRODUCTS
Excess of exports over imports
Exports
Imports
July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov.
1931
1932
1933

MARKETS

Withdrawals of chemicals against running contracts continued to involve a large tonnage and trading throughout July was active. Buying in the open market has declined since the turn of the month and August promises to show a recession from July total. Prices hold to an upward curve despite aggressive selling in some selections.

STEADY movement of chemicals against running contracts featured the market throughout the last month. Most of the large consuming industries maintained their June rate of operations and the customary slowing up in the warm weather period was not in evidence. The fertilizer trade has passed its active period and consumption of fertilizer chemicals was reported on a lower scale but favorable reports are heard regarding prospects for the latter part of the year.

The alcohol market was enlivened by keen competition for anti-freeze trade and numerous contracts have been placed for delivery through next January. Prices were unsettled in the selling campaign with a sharp drop in the open quotation for C. D. alcohol No. 5.

Reorganization of the Chilean nitrate industry is proposed in a bill submitted to the Congress by the Chilean President. This would establish a monopoly for the sale of nitrate and iodine through a single sales corporation which would acquire all stocks existing on July 1, 1933 and the subsequent output of the nitrate industry. The sales corporation would have a directorate of twelve, of whom three would be appointed by the President of Chile and the remainder elected by the majority of producing enterprises.

Stocks of nitrate now held abroad would be acquired by the sales corporation for the sum of the obligations which such stocks now guarantee, the payment of which would be assumed by the corporation; iodine held abroad would be acquired for £0-8-9.82 per kilo; nitrate in Chile for £3 per metric ton and iodine in Chile for £0-5-10.55 f.a.s. nitrate ports. The price of nitrate and iodine produced after July 1, 1933 would be its "industrial" cost f.a.s. nitrate ports, exclusive of depreciation of machinery, the depletion of lands and the interest and service on debts. To this industrial cost price, there would be added $1.50 U. S. currency per metric ton subordinated to the prior service of the bonded indebtedness of the corporation.

The selling corporation would fix the selling price and the sales quotas of producers. Initial quotas shall be effective for seven years. Of these initial quotas, two-thirds shall be allocated jointly to the Lautaro Nitrate Corp. and the Anglo Chilean Nitrate Corp. and one-third to the Cia. de Salitre de Chile. If production of nitrate is undertaken by enterprises not now a part of Cosach in agreement with the directorate of the selling corporation, the quotas assigned to them shall be deducted from the quotas allocated to the above mentioned companies. Iodine sales quotas shall be distributed according to the nitrate quotas. The Iodine Producers Association is to be dissolved.

The stocks of nitrate on hand on June 30, 1933 shall be liquidated by selling from such stocks not less than 20 per cent nor more than 30 per cent of the total sales in any nitrate year. As stocks are liquidated, sales quotas of producers for new production may be progressively increased.

During the present calendar year, the nitrate and iodine industry must pay to the government the sum of 140,000,000 pesos. As part payment of this sum there may be applied the amounts which the government may receive as export duties, its share of the profits under operating contracts with nitrate enterprises, fiscal real property taxes, income taxes and indemnities for occupancy of fiscal lands plus one-half of the 25% share in the profits of the selling corporation during the nitrate year beginning July 1, 1933 and shall also apply against this 140,000,000 pesos such profits of the selling corporation as would correspond to the industrialists, and should these profits prove insufficient for this purpose the selling corporation may deduct the difference from the sums paid to producers for nitrate stocks to be acquired on July 1.

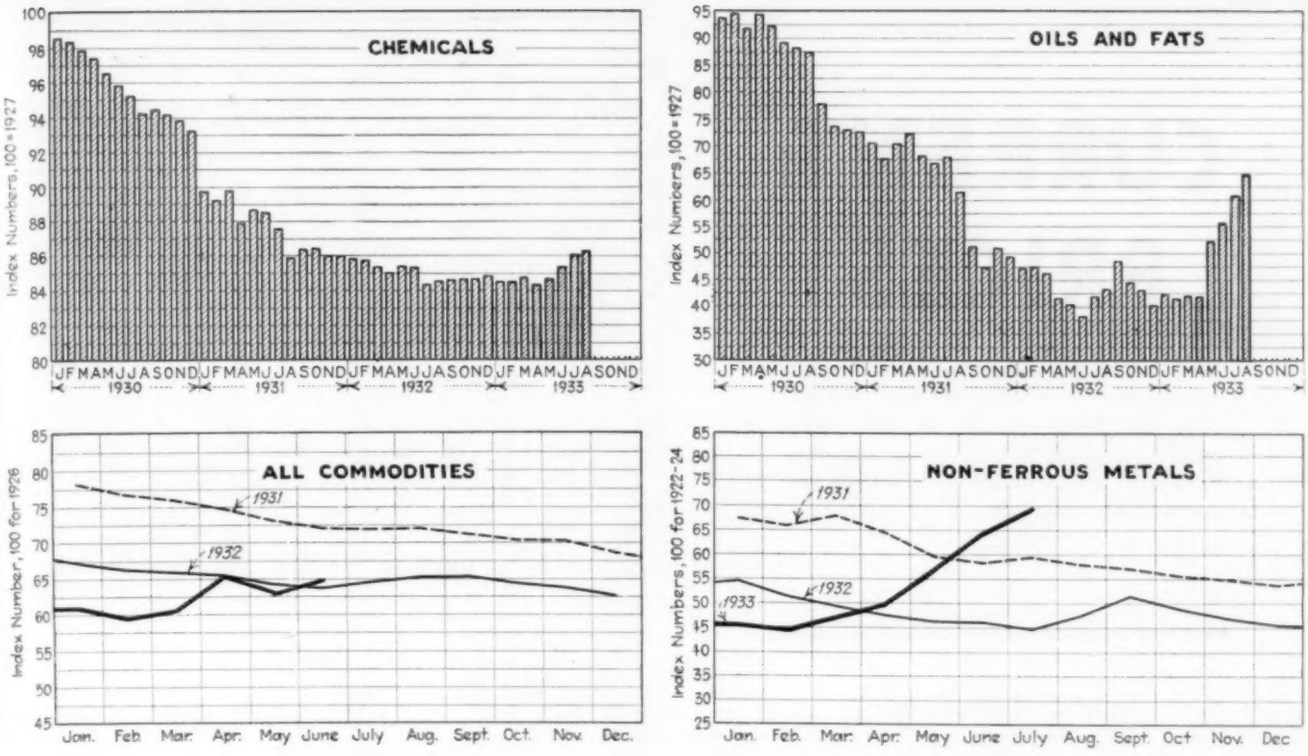
After July 1, 1933 the profits of the selling corporation would be distributed, 25 per cent to the government and 75 per cent to producers after expenses have been deducted. Of the 75 per cent, prior payment must be made on the interest and amortization of the bonds of this corporation and the remainder may be distributed to producers according to their sales quotas after adjusting the prices paid on account of costs in such a manner that they shall be the same for all.

A new outlet for zinc sulphate may be opened up as a result of experimental work carried out by the Department of Agriculture. The rosette disease has been responsible for the abandonment of hundreds of acres of pecan orchards in Florida, Georgia, and Alabama, and it has also appeared in groves in Mississippi, Louisiana, and Texas. Investigations carried on jointly by the Bureaus of Plant Industry and Chemistry and Soils, have shown that the rosette disease can be cured or prevented by the use of zinc sulphate. They have found three ways in which the zinc sulphate may be used. It may be sprayed on to the trees in solution or injected into the trunk of the tree or applied directly to the soil.

Germans Delay Issuance Of Fertilizer Prices

THE new German domestic price list for nitrogenous fertilizers, which the German Nitrogen Syndicate customarily issues each year before July 1, has not yet been published and is being withheld pending the results of an official inquiry regarding the prices proposed by the Syndicate. In the meantime, all sales by the Syndicate are being billed tentatively under the price levels and sales conditions for July, 1932, with the understanding that any necessary adjustment required by the Government's findings will be made later on.

The delay in issuing the new price schedule for nitrogen is indicative of the aggressive role the Government intends to play in the regulation of German business, especially the regulation of prices charged by trusts.


CHEMICALS
Index Numbers, 100 = 1927
JF MAMJJASOND JF MAMJJASOND JF MAMJJASOND JF MAMJJASOND JF MAMJJASOND
1930 1931 1932 1933
OILS AND FATS
Index Numbers, 100 = 1927
ALL COMMODITIES
Index Number, 100 for 1926
1931
1932
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.
NON-FERROUS METALS
Index Numbers, 100 for 1922-24
1931
1932
1933
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct Nov. Dec

PRICE TRENDS—CHEM. & MET.'S WEIGHTED INDEXES

THE Bureau of Labor Statistics has just completed a survey of price trends which is said to have been undertaken as a step in the national recovery plan and which, therefore, may carry a threat of price legislation if values in the future show disproportionate fluctuations. The survey places the decline in the general index from June, 1929, to June, 1933, at 31.7 per cent. The index for chemicals in the same period is reported at a decline of 16.7 per cent. The weighted index of *Chem. & Met.* dropped slightly less than 15 per cent from June, 1929, to June, 1933.

Continuing the trend in evidence for the last few months the weighted index number for chemicals again moved upward in the last month, although some items ran counter to the general trend. Recent trading has demonstrated that a rising price trend is not a guarantee against declines whenever competition reaches the price-cutting stage. Basically, however, the market has revealed a strong undertone. In the first place recent demand from practically all consuming directions has favored firmer prices. In addition there has been a rise in values for most raw materials which directly affects producing costs. To this now may be added higher overhead as represented by the terms of the respective codes which carry regulations affecting hours of labor and minimum wage scales.

While prices for chemicals from 1929 to date did not decline in anything like the proportion reported for commodities in general, the price movement for chemicals from 1920 up to a few months ago has been steadily downward, with 1923 and 1929 offering the only exceptions. This price movement resulted from improvements in equipment and processes, from the development of new products, and in some degree from improved marketing methods. These economic advances may set chemicals aside as an exception in the reported plan to restore prices to the 1924 or 1925 levels, but it is of interest to note that the weighted price index for chemicals in June, 1924, was 103.61, which is 10 per cent over the present price level.

In the case of vegetable oils, the price decline since 1929 was severe in common with the fall in natural products. The recovery to date likewise has been more pronounced and the course of farm products undoubtedly will be paralleled in the movement of the various oils. So far coconut oil has been influenced more by conditions in foreign oil and copra markets than by developments in domestic markets, but the interdependence of oils makes it improbable that one oil can for long remain below the parity of the general group.

Chem. & Met. Weighted Index of Chemical Prices

Base = 100 for 1927

This month	**86.26**
Last month	86.01
August, 1932	84.53
August, 1931	85.77

For the greater part, a firm price tone was in evidence throughout the market for chemicals in the last month. Lower prices prevailed for a few selections but price changes generally were in favor of higher levels. Increased production cost stands out as the principal factor creating confidence in the stability of values.

Chem. & Met. Weighted Index of Prices for Oils and Fats

Base = 100 for 1927

This month	**64.98**
Last month	61.44
August, 1932	43.41
August, 1931	61.53

While some of the vegetable oils closed below the highest levels reached during the past month, the trend continued upward. Crude cottonseed oil led in the rising movement and China wood also held a materially higher price average. Coconut oil and animal fats fluctuated but little.

CURRENT PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to Aug. 14.

Industrial Chemicals

	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.08½–$0.09	$0.08½–$0.09	$0.10 –$0.11
Acid, acetic, 28%, bbl., cwt.	2.90 – 3.15	2.90 – 3.15	2.65 – 2.90
Glacial 99%, drums	10.02 –10.27	10.02 –10.27	8 89 –
U. S. P. reagent, c'bys.	10.52 –10.77	10.52 –10.77	9.64 – 9.89
Boric, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Citric, kegs, lb.	.29 – .31	.29 – .31	.30 – .31
Formic, bbl., lb.	.10½– .11	.10 – .11	.10 – .11
Gallic, tech., bbl., lb.	.60 – .65	.55 – .60	.50 – .55
Hydrofluoric 30% carb., lb.	.06 – .07	.06 – .07	.06 – .07
Lactic, 44%, tech., light, bbl., lb.	.11½– .12	.11½– .12	.11½– .12
22%, tech., light, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Muriatic, 18° tanks, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1 10
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –	18.50 –20. 00
Oxalic, crystals, bbl., lb.	.11 – .11½	.11 – .11½	.11 – .12
Phosphoric, tech., c'bys., lb.	.08½– .09	.08½– .09	.08½– .09
Sulphuric, 60°, tanks, ton	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton	15.50 –	15.50 –	15.50 –
Tannic, tech., bbl., lb.	.23 – .35	.23 – .35	.23 – .35
Tartaric, powd., bbl., lb.	.23 – .24	.23 – .24	.23 – .24
Tungstic, bbl., lb.	1.40 – 1.50	1.40 – 1.50	1.40 – 1.50
Alcohol, ethyl, 190 p'f., bbl., gal.	2.53½–	2.53½–	2.53½–
Alcohol, Butyl, tanks, lb.	.09½–	.09½–	.11½–
Alcohol, Amyl.	–	–	–
From Pentane, tanks, lb.	.15 –	.15 –	.182–
Denatured, 190 proof			
No. 1 special dr., gal.	.34½–	.34½–	.34½–
No. 5, 188 proof, dr., gal.	.34 –	.38½–	.38½–
Alum, ammonia, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Aluminum sulphate, com., bags, cwt.	1.25 – 1.40	1.25 – 1.40	1.25 – 1.40
Iron free, bg., cwt.	1.90 – 2.00	1.90 – 2.00	1.90 – 2.00
Aqua ammonia, 26°, drums lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02¾	.02½– .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb.	.15½– .15¾	.15½– .15¾	.15½– .15¾
tanks, lb.	.05 –	.05 –	.05½–
Ammonium carbonate, powd tech., casks, lb.	.08 – .12	.08 – .12	.10 – .11
Sulphate, wks., cwt.	1.20 –	1.125–	1.00 –
Amylacetate tech., tanks, lb., gal	.14½–	.135–	.16 –
Antimony Oxide, bbl., lb.	.08½– .10	.07½– .08	.06½– .08
Arsenic, white, powd., bbl., lb.	.04 – .04½	.04 – .04½	.04 – .04½
Red, powd., kegs, lb.	.13 – .14	.11½– .12	.09 – .10
Barium carbonate, bbl., ton	56.50 –58.00	56.50 –58.00	56.50 –58.00
Chloride, bbl., ton	61.50 –65.00	61.50 –65.00	63.00 –65.00
Nitrate, cask, lb.	.07½– .07¾	.07½– .07¾	.07 – .07¾
Blanc fixe, dry, bbl., lb.	.03 – .04	.03 – .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt.	1.75 – 2.00	1.75 – 2.00	1.75 – 2.00
Borax, grain, bags, ton	40.00 –45.00	40.00 –45.00	40.00 –45.00
Bromine, cs., lb.	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	3.00 –	3.00 –	2.50 –
Arsenate, dr., lb.	.07 – .08	.07 – .08	.05½– .06½
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., wks., ton	17.50 –	17.50 –	18.00 –
flake, dr., wks., ton	19.50 –	19.50 –	21.00 –
Phosphate, bbl., lb	.07½– .08	.07½– .08	.08 – .08½
Carbon bisulphide, drums, lb.	.05½– .06	.05½– .06	.05 – .06
Tetrachloride drums, lb.	.05½– .06	.05½– .06	.06½– .07
Chlorine, liquid, tanks, wks., lb.	.01½–	.01½–	.01½–
Cylinders	.05½– .06	.05½– .06	.05 – .06
Cobalt oxide, cans, lb.	1.15 – 1.25	1.15 – 1.25	1.25 – 1.35
Copperas, bgs., f.o.b. wks., ton.	14.00 –15.00	14.00 –15.00	13.00 –14.00
Copper carbonate, bbl., lb.	.08½– .16	.07 – .16	.07 – .16
Cyanide, tech., bbl., lb.	.39 – .44	.39 – .44	.39 – .44
Sulphate, bbl., cwt.	3.75 – 4.00	3.75– 4.00	2.75 – 2.90
Cream of tartar, bbl., lb.	.16½– .17	.15½– .16	.17 – .17½
Diethylene glycol, dr., lb.	.14 – .16	.14 – .16	.14 – .16
Epsom salt, dom., tech., bbl., cwt.	1.70 – 2.00	1.70 – 2.00	1.70 – 2.00
Imp., tech., bags, cwt.	1.35 – 1.40	1.35 – 1.40	1.15 – 1.25
Ethyl acetate, drums, lb.	.08½–	.08½–	.10 –
Formaldehyde, 40%, bbl., lb.	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., contract, lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, crude, drums, gal.	.75 –	.75 –	1.10 – 1.20
Refined, dr., gal.	1.25 – 1.30	1.25 – 1.30	1.80 – 1.90
Glaubers salt, bags, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Glycerine, c.p., drums, extra, lb.	.10½– .10¾	.10½– .10¾	.10½– .10¾
Lead:			
White, basic carbonate, dry casks, lb.	.06½–	.06½–	.06½–
White, basic sulphate, sck., lb.	.06 –	.06 –	.06 –
Red, dry, sck., lb.	.08 –	.07½–	.06½–
Lead acetate, white crys., bbl., lb.	.10½– .11	.10½– .11	.10 – .11
Lead arsenate, powd., bbl., lb.	.10 – .13	.10 – .13	.10 – .14
Lime, chem., bulk, ton	8.50 –	8.50 –	8.50 –
Litharge, pwd., csk, lb.	.07 –	.07 –	.05½–
Lithophone, bags, lb.	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb.	.05½– .06	.05½– .06	.05½– .06
Methanol, 95%, tanks, gal.	.33 –	.33 –	.33 –
97%, tanks, gal.	.34 –	.34 –	.34 –
Synthetic, tanks, gal.	.35½–	.35½–	.35½–
Nickel salt, double, bbl., lb.	.12 – .12½	.12 – 12½	.10½– .11
Orange mineral, csk., lb.	.10½–	.10½–	.09 –
Phosphorus, red, cases, lb.	.45 – .46	.45 – .46	.42 – .44
Yellow, cases, lb.	.28 – .32	.28 – .32	.31 – .32
Potassium bichromate, casks, lb.	.07½– .08	.07½– .08	.08 – .08½
Carbonate, 80-85%, calc. csk., lb	.06½– .07	.05½– .06	.05 – .06
Chlorate, powd., lb.	.08½– .08¾	.08½– .08¾	.08 – .08¾
Hydroxide (c'stic potash) dr., lb.	.07½– .07¾	.07½– .07¾	.06½– .06¾
Muriate, 80% bgs., ton	37.15 –	37.15 –	37.15 –
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.17½– .18	.16 – .16½	.16 – .16½
Prussiate, yellow, casks, lb.	.16½– .17	.16½– .17	.18½– .19
Sal ammoniac, white, casks, lb.	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt.	.90 – .95	.90 – .95	.90 – .95
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.20 –	1.20 –	1.15 –
Dense, bags, cwt.	1.22½–	1.22½–	1.17½–
Soda, caustic, 76%, solid, drums, contract, cwt.	2.50 – 2.75	2.50 – 2.75	2.50 – 2.75
Acetate, works, bbl., lb.	.04½– .05	.04½– .05	.05 – .05½
Bicarbonate, bbl., cwt.	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb.	.05½– .05½	.04½– .05	.05 – .06
Bisulphate, bulk, ton	14.00 –16.00	14.00 –16.00	14.00 –16.00
Bisulphite, bbl., lb.	.03 – .04	.03 – .04	.03½– .04
Chlorate, kegs, lb.	.05½– .07½	.05½– .07½	.05½– .07½
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.00
Cyanide, cases, dom., lb.	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb.	.07 – .08	.07 – .08	.07½– .08
Hyposulphite, bbl., lb.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	3.25 – 3.40	3.25 – 3.40	3.60 – 3.75
Nitrate, bags, cwt.	1.295–	1.345–	1.77 –
Nitrite, casks, lb	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb.	.02 – .023	.02– .023	.0255 – .0275
Prussiate, yel. drums, lb.	.11½– .12	.11½– .12	.11½– .12
Silicate (40° dr.) wks. cwt.	.70 – .75	.70 – .75	.70 – .75
Sulphide, fused, 60-62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyrs., bbl., lb.	.03 – .03½	.03 – .03½	.03 – .03½
Sulphur, crude at mine, bulk, ton	18.00 –	18.00 –	18.00 –
Chloride, dr., lb.	.03½– .04	.03½– .04	.03½– .04
Dioxide, cyl., lb.	.06½– .07	.06½– .07	.06½– .07
Flour, bag, cwt.	1.55 – 3.00	1.55 – 3.00	1.55 – 3.00
Tin bichloride, bbl., lb.	nom.–	nom.–	nom.–
Oxide, bbl., lb.	.50 –	.47 –	.25½–
Crystals, bbl., lb.	.36½–	.35½–	.23 –
Zinc chloride, gran., bbl., lb.	.06½– .06¾	.06½– .06¾	.06½– .06¾
Carbonate, bbl., lb.	.10½– .11	.10½– .11	.10½– .11
Cyanide, dr., lb.	.38 – .42	.38 – .42	.41 – .42
Dust, bbl., lb.	.06½– .07	.06½– .07	.04½– .05
Zinc oxide, lead free, bag, lb.	.05½–	.05½–	.05½–
5% lead sulphate, bags, lb.	.05½–	.05½–	.05½–
Sulphate, bbl.; cwt.	3.00 – 3.25	3.00 – 3.25	3.00 – 3.25

Oils and Fats

	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.09½–$0. 10	$0.08½–$0.09	$0.09½–$0.10
Chinawood oil, bbl., lb.	.08–	.08½–	.05½–
Coconut oil, Ceylon, tanks, N. Y. lb.	.03½–	.03½–	.03½–
Corn oil crude, tanks, (f.o.b. mill), lb	.05½–	.06½–	.03½–
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.03½–	.04½–	.03½–
Linseed oil, raw car lots, bbl., lb.	.104–	.109–	.053–
Palm, Lagos, casks, lb.	.04½–	.04½–	.03½–
Palm Kernel, bbl., lb.	.04½–	.04½–	.04½–
Peanut oil, crude, tanks (mill), lb.	.05½–	.06 –	.03½–
Rapeseed oil, refined, bbl., gal.	.66 – .68	.49 – .50	.31 – .32
Soya bean, tank (f.o.b. Coast), lb.	nom.–	nom.–	nom.–
Sulphur (olive foots), bbl., lb.	.06½–	.05½–	.04½–
Cod, Newfoundland, bbl., gal.	nom.–	nom.–	.25 – .26
Menhaden, light pressed, bbl., lb;	.053–	.051–	.04 –
Crude, tanks (f.o.b. factory), gal.	.17 –	.15 –	.12 –
Grease, yellow, loose, lb.	.03½–	.03½–	.02½–
Oleo stearine, lb.	.06 –	.05 –	.05½–
Red oil, distilled, d.p. bbl., lb.	.06½–	.06½–	.06½–
Tallow, extra, loose, lb.	.03½–	.03½–	.02½–

Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude, bbl., lb.	$0.60 -$0.65	$0.60 -$0.65	$0.60 -$0.62
Refined, bbl., lb.	.80 - .85	.80 - .85	.80 - .85
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.14½- .15	.14½- .15	.14½- .15
Aniline salts, bbl., lb.	.24 - .25	.24 - .25	.24 - .52
Benzaldehyde, U.S.P., dr., lb.	1.10 - 1.25	1.10 - 1.25	1.10 - 1.25
Benzidine base, bbl., lb.	.65 - .67	.65 - .67	.65 - .67
Benzoic acid, U.S.P., kgs, lb.	.48 - .52	.48 - .52	.48 - .52
Benzyl chloride, tech., dr., lb.	.30 - .35	.30 - .35	.30 - .35
Benzol, 90%, tanks, works, gal.	.22 - .23	.22 - .23	.20 - .21
Beta-naphthol, tech., drums, lb.	.22 - .24	.22 - .24	.22 - .24
Cresol, U.S.P., dr., lb.	.10½- .11	.10½- .11	.10½- .11
Cresylic acid, 97%, dr., wks., gal.	.45 - .46	.40 - .42	.49 - .52
Diethylaniline, dr., lb.	.55 - .58	.55 - .58	.55 - .58
Dinitrophenol, bbl., lb.	.29 - .30	.29 - .30	.29 - .30
Dinitrotoluen, bbl. lb.	.16 - .17	.16 - .17	.16 - .17
Dip oil 25% dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.38 - .40	.38 - .40	.38 - .40
H-acid, bbl., lb.	.65 - .70	.65 - .70	.65 - .70
Naphthalene, flake, bbl., lb.	.04½- .05	.04½- .05	.03½- .04¼
Nitrobenzene, dr., lb.	.08½- .09	.08½- .09	.08½- .10
Para-nitraniline, bbl., lb.	.51 - .55	.51 - .55	.51 - .55
Phenol, U.S.P., drums, lb.	.14½- .15	.14½- .15	.14½- .15
Picric acid, bbl., lb.	.30 - .40	.30 - .40	.30 - .40
Pyridine, dr., gal.	.90 - .95	.90 - .95	1.50 - 1.80
R-salt, bbl., lb.	.40 - .44	.40 - .44	.40 - .44
Resorcinal, tech., kegs, lb.	.65 - .70	.65 - .70	.65 - .70
Salicylic acid, tech., bbl., lb.	.40 - .42	.40 - .42	.33 - .35
Solvent naphtha, w.w., tanks, gal.	.26 -.....	.26 -.....	.26 -.....
Toludine, bbl., lb.	.88 - .90	.88 - .90	.86 - .88
Toluene, tanks, works, gal.	.30 -.....	.30 -.....	.30 -.....
Xylene, com., tanks, gal.	.26 -.....	.26 -.....	.26 -.....

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton.	$22.00-$25.00	$22.00-$25.00	$22.00-$25.00
Casein, tech., bbl., lb.	.14½- .15	.11½- .13½	.06 - .10½
China clay, dom., f.o.b. mine, ton	8.00 -20.00	8.00 -20.00	8.00 -20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.02½- .20	.02½- .20	.02½- .20
Prussian blue, bbl., lb.	.35 - .36	.35 - .36	.35 - .36
Ultramine blue, bbl., lb.	.06 - .32	.06 - .32	.06 - .32
Chrome green, bbl., lb.	.26 - .27	.26 - .27	.27 - .30
Carmine red, tins, lb.	3.65 - 3.75	3.65 - 3.75	3.90 - 4.50
Para toner, lb.	.80 - .85	.80 - .85	.75 - .80
Vermilion, English, bbl., lb.	1.40- 1.45	1.32 - 1.35	1.30 - 1.50
Chrome yellow, C. P., bbl., lb.	.15 - .15½	.15 - .15½	.16 - .16½
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 - .08½	.07 - .08½	.07 - .08½
Gum copal Congo, bags, lb.	.08 - .09	.07½- .09	.06 - .08
Manila, bags, lb.	.09 - .10	.09 - .10	.16 - .17
Damar, Batavia, cases, lb.	.15 - .15½	.12½- .13	.16 - .16½
Kauri No. 1 cases, lb.	.20 - .25	.20 - .25	.45 - .48
Kieselguhr (f.o.b. N.Y.), ton.	50.00 -55.00	50.00 -55.00	50.00 -55.00
Magnesite, calc, ton	50.00 -.....	40.00 -.....	40.00 -.....
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported, casks, lb.	.03 - .40	.03 - .40	.03 - .35
Rosin, H., bbl.	5.10 -.....	5.50-.....	3.65 -.....
Turpentine, gal.	.49½-.....	.53½-.....	.42½-.....
Shellac, orange, fine, bags, lb.	.24 - .25	.20 - .21	.20 - .25
Bleached, bonedry, bags, lb.	.24 - .25	.22 - .23	.16 - .17
T. N. bags, lb.	.15 - .16	.12½- .13	.09½- .10
Soapstone (f.o.b. Vt.), bags, ton	10.00 -12.00	10.00 -12.00	10.00 -12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b Ga.), ton.	7.50 -10.00	7.50 -10.00	7.50 -11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 -.....	13.75 -.....	13.75 -.....
Wax, Bayberry, bbl., lb.	.14 - .15	.14 - .15	.16 - .20
Beeswax, ref., light, lb.	.22 - .27	.22 - .27	.25 - .27
Candelilla, bags, lb.	.09½- .10	.09½- .10	.11 -.....
Carnuba, No. 1, bags, lb.	.29 - .30	.30 - ...	.21 - .23
Paraffine, crude			
105-110 m.p., lb.	.03¼-.....	.02¾-.....	.03½- .03¾

Price Changes During Month

Advanced	Declined
Ammonium sulphate	C. D. Alcohol
Amyl acetate	Rosin
Red Arsenic	Turpentine
Copper carbonate	
Cream of tartar	
Sodium bichromate	
Tin salts	
Casein	
Mercury	
Cottonseed oil	

Ferro-Alloys

	Current Price	Last Month	Last Year
Ferrotitanium, 15-18%, ton.	$200.00-.....	$200.00-.....	$200.00-.....
Ferromanganese, 78-82%, ton.	82.00-.....	78.00-.....	68.00-.....
Ferrochrome, 65-70%.	.09½-.....	.09½-.....	.10-.....
Spiegeleisen, 19-21%, ton.	24.00-.....	24.00-.....	27.00-.....
Ferrosilicon, 14-17%, ton.	31.00-.....	31.00-.....	31.00-.....
Ferrotungsten, 70-80%, lb.	.95- 1.00	.95- 1.00	1.00- 1.10
Ferrovanadium, 30-40%, lb.	2.60- 2.80	2.60- 2.80	3.05- 3.40

Non-Ferrous Metals

	Current Price	Last Month	Last Year
Copper, electrolytic, lb.	$0.09 -.....	$0.09 -.....	$0.05½-.....
Aluminum, 96-99%, lb.	.229-.....	.229-.....	.229-.....
Antimony, Chin. and Jap., lb.	.07½-.....	.06½-.....	.05 -.....
Nickel, 99%, lb.	.35 -.....	.35 -.....	.35 -.....
Monel metal blocks, lb.	.28 -.....	.28 -.....	.28 -.....
Tin, 5-ton lots, Straits, lb.	.44½-.....	.46½-.....	.21½-.....
Lead, New York, spot, lb.	.045-.....	.045 -.....	.031-.....
Zinc, New York, spot, lb.	.0537-.....	.0522-.....	.0312-.....
Silver, commercial, oz.	.36½-.....	.37½-.....	.28½-.....
Cadmium, lb.	.55 -.....	.55 -.....	.55 -.....
Bismuth, ton lots, lb.	1.05 -.....	.85 -.....	.85 -.....
Cobalt, lb.	2.50 -.....	2.50 -.....	2.50 -.....
Magnesium, ingots, 99%, lb.	.32 -.....	.32 -.....	.30 -.....
Platinum, ref., oz.	33.00 -.....	31.00 -.....	35.00 -.....
Palladium, ref., oz.	19.00 -.....	19.00 -.....	18.00 - 19.00
Mercury, flask, 75 lb.	63.00 -.....	62.00 -.....	48.50 -.....
Tungsten powder, lb.	1.25 -.....	1.25 -.....	1.45 -.....

Ores and Semi-finished Products

	Current Price	Last Month	Last Year
Bauxite, crushed, wks., ton.	$6.50 -$8.25	$6.50 -$8.25	$6.50 -$8.25
Chrome ore, c.i.f. ports, ton.	14.00 -18.50	14.00 -18.50	17.00 -20.00
Coke, fdry., f.o.b. ovens, ton.	2.25 -.....	2.25 -.....	3.25 - 3.75
Fluorspar, gravel, f.o.b. Il., ton.	17.25 -20.00	17.25 -20.00	17.25 -20.00
Manganese ore, 50% Mn., c.i.f. Atlantic Ports, unit.	.19 -.....	.19 - ...	.25 - .27
Molybdenite, 85% MoS_2 per lb. MoS_2, N. Y., lb.	.45 -.....	.45 -.....	.45 -.....
Monazite, 6% of ThO_2, ton..	60.00 -.....	60.00 -.....	60.00 -.....
Pyrites, Span. fines, c.i.f., unit.	.13 -.....	.13 -.....	.13 -.....
Rutile, 94-96% TiO_2, lb.	.10 - .11	.10 - .11	.10 - .11
Tungsten, scheelite, 60% WO_3 and over, unit.	10.00 -10.50	10.00 -10.50	10.00 -10.50

INDUSTRIAL NOTES

THE MASON REGULATOR CO., Boston, Mass,. and the Neilan Co., Ltd., Los Angeles, Calif., have consolidated under the name of Mason-Neilan Regulator Co. All departments of the two companies are now located at 1190 Adams St., Boston.

CHAIN BELT CO., Milwaukee, Wis., has moved its office in St. Louis to 5475 Cabanne Ave. The St. Louis branch, managed by Fitch S. Bosworth, supervises a territory including the southern half of Illinois, the eastern half of Missouri, and the southwestern corner of Iowa.

LUMBER BI-PRODUCTS, INC., M & T Bldg., Buffalo, N. Y., has enlarged its activities by establishing a wood flour division, having purchased the assets of the former New England mills at Manchester, N. H.

THE GRAY PROCESSES CORP., owner of the Gray vapor-phase clay-treating processes for refining cracked gasoline, has entered into licensing agreements with The Texas Co., the Standard Oil Co. (Indiana), the Pure Oil Co., and the Standard Oil Development Co.

TAKAMINE CORP., Long Island City, N. Y., on Aug. 5 moved its offices to 132 Front St., New York City.

THE KRON CO., Bridgeport, Conn., has appointed as distributors of its equipment: Elbert & Kirkman Co., Inc., Birmingham, Ala., William N. Schwab, Los Angeles, Calif., and Coe-Mantes Scale Co., San Francisco, Calif.

COOLEY ELECTRIC FURNACE CO. has been established at 47-32 Van Dam St., Long Island City, N. Y. W. B. Cooley, who has been associated with the electric furnace business for many years, is in charge. An exclusive license for the use in electric furnaces of the Doreco heating element has been granted by the Doherty Research Corp.

HOMESTEAD VALVE MFG. CO., Coraopolis, Pa., has appointed Reeves-McCormick, Inc., as its representative in the Philadelphia district.

CHEMICAL SOLVENTS, INC., on Aug. 1 moved its offices to 11 Park Place, New York City.

COLGATE-PALMOLIVE-PEET CO., Jersey City, N. J., has acquired a controlling interest in Compania Nacional de Perfumeria, S. A. of Havana, Cuba.

NEW CONSTRUCTION

Where Plants Are Being Built in Process Industries

	This Month		Cumulative to Date	
	Proposed Work and Bids	Contracts Awarded	Proposed Work and Bids	Contracts Awarded
New England	85,000	.....	320,000	$165,000
Middle Atlantic	564,000	914,000	3,519,000	3,418,000
Southern	3,153,000	2,898,000	6,276,000	3,467,000
Middle West	190,000	126,000	1,266,000	483,000
West of Mississippi	78,000	250,000	10,849,000	14,064,000
Far West	830,000	38,000	2,664,000	934,000
Canada	588,000	125,000	4,793,000	347,000
Total	$5,488,000	$4,351,000	$29,687,000	$22,878,000

PROPOSED WORK BIDS ASKED

Bromine Plant—Ethyl Dow Chemical Co., Wilmington, N. C., W. Dow, pres., 60 East 42nd St., New York, plans manufacturing plant to extract bromine from sea water for conversion into bromine, to be erected on shore, at Kure Beach, 20 mi. south of here, consisting of two 80x190 ft. brick units. Monthly output of bromine to be 500,000 lbs. Est. $3,000,000. Excavation for plants awarded to Hodge Constr. Co., New Bern.

Plant—Canadian Bronze Company Ltd., Montreal, Que., contemplates constructing addition to plant. $25,000.

Chemical Plant — Va-Carolina Chemical Co., Charlotte, N. C., G. A. Holderness, Richmond, Va., plans rebuilding large chemical plant recently destroyed by fire at Charlotte, N. C.

Chemical Building—City, Toronto, Ont., R. C. Harris, engr., City Hall, plans constructing a new chemical building at the John St. Pumping Station. $40,000.

Hydrogenation Plant—Imperial Chemical Industries Ltd., London, England, contemplates constructing plant for manufacturing oils and distillates from coal in Durham County, England. $15,000,000.

Copper Refinery—Rhokana Corp. Ltd., London, England, plans electrolytis copper refinery, 36,500 tons annual capacity in the vicinity of company's North Kava Min in Rhodesia, Africa.

Disinfectant Factory—T. P. Non-Odourous Disinfectants Co., Ltd., K. Victor Campbell, Mgr., Vancouver, B. C., plans constructing a factory to manufacture disinfectants at North Vancouver, B. C.

Distillery — Hiram Walker & Sons Ltd., Walkerville, Ont., are having plans completed for a distillery to be erected in Peoria, Ill. Private plans. $1,000,000.

Factory—Strand Enamel Co., Torrington Rd., Winsted, Conn., are preparing plans for a 1 story, 50x62 ft. factory for making enameled wire and insulation for copper wire. Private plans. $40,000.

Explosives Plant—Canadian Industries Ltd., Beloeil, Que., plans repairing and altering explosives plant at Beloeil. $40,000.

Gas Plant—City of Compton, J. H. Park, City Mgr., City Hall, Compton, Calif., to make application to the Federal Government for funds under National Industrial Recovery Act for construction of a municipal gas plant and a municipal light and power plant. $500,000.

Research Laboratory—Board of Governors University of Western Ontario, Dr. S. Fox, pres., are having preliminary plans prepared by O. Roy Moore, archt., 489 Richmond St., London, Ont., for 3 story, basement 50x116 ft. cancer clinic building and research laboratory to be built on Victoria Hospital grounds, Ottoway Ave., London, Ont. Bids will probably be called about the last of August. $185,000.

Factory—Stamford Wall Paper Co., Greenwich Ave., Stamford, Conn., contemplates the construction of a brick factory unit. Private plans. $45,000.

Tissue Mills—Brockway Tissue Mills Ltd., F. G. Bush, Mgr., Montreal, Que., plans constructing a mill. $50,000.

Pulp and Paper Mills—Anglo-Newfoundland Development Co. Ltd., London, England, plans the construction of a pulp and paper mills at Newfoundland, project to be financed from part of £1,750,000 bond issue.

Smelter—Mojave Smelting Co., Reno, Nev., plans the construction of a 50-ton capacity smelter at company properties at Mojave, Kern County, Calif. $250,000.

Factory—Peterson Tallow Co., 65th and Bay Sts., Oakland, Calif., are having plans prepared for a 2 story 120x140 ft. factory on 63rd and Overland Sts. E. W. Remnitz, 1594 63rd St., is the engr. $50,000.

Plant—Commercial Solvents Corp., Terre Haute, Ind., plans the construction of an addition to plant. Private plans. $190,000.

Gasoline Plant—Syndicate, c/o M. Merriweather, Los Angeles, Calif., or c/o Chamber of Commerce, Calgary, Alta., plans constructing gasoline and carbon black plant, at Calgary, Alberta. $30,000.

Stills—Lion Oil Co., El Dorado, Ark., plans repairs of fire damage and rebuilding of stills. Private plans. $50,000.

Refinery and Storage—Trio Refining Co., Shreveport, La., plans constructing refinery and storage at Overton, Tex. $28,000.

Oil Refinery—George Cantovich, Red Lodge, Mont., plans the construction of a 10,000 gal. capacity oil refinery.

Oil Refinery Plant—Owner, c/o J. Knecht, archt., 403 Ward St., Union, N. J., plans constructing a 3 story oil refinery plant at foot of Lockwood St. $28,500.

Refinery—Sloan & Zook Refining Co., Bradford, Pa., plans constructing refinery additions including additional 1,500 bbl. still, at Warren, Pa. $35,000.

Refinery — Maple Leaf Oil & Refining Co., Ltd., Coutts, Alta., manufacturer of gasoline, fuel and gas oils and kerosene, contemplates the construction of an addition to its refinery.

Refinery—Swift Current Oil Refinery Co., c/o George Bremner, Swift Current, Sask., plans refinery. $40,000.

Refining Stills — Wentworth Refineries Ltd., Burlington St., Hamilton, Ont., will soon call for bids for steel tanks, refining stills and pumphouse. B. V. Hole, 159 Bay St., Toronto, is engr. $30,000.

Refinery—Swift Oil Co. Ltd., Mimico, Ont., plans the construction of a plant and refinery.

Rubber Plant—St. Lawrence Rubber Co. Ltd., c/o Maurice Dugas, K. C., Montreal, Que., plans constructing a plant. $50,000.

CONTRACTS AWARDED

Factory—American Commercial Alcohol Corp., Delaware Ave. and Tasker St., Phila., Pa., awarded contract for a 3 story, 80x90 ft. manufacturing building on Delaware Ave. and Tasker St., to S. H. Levin, 1619 Sansom St., Phila., Pa. $50,000.

Cement Plant—Petoskey Portland Cement Co., will build by separate contract and day labor plant repairs and alterations at Petoskey, Mich. $28,000.

Factory—Stauffer Chemical Co., Rives-Strong Bldg., Los Angeles, Calif., awarded contract for 1 story, 100x200 ft. factory on East 26th St., to McKittrick Co., 5905 Pacific Blvd., Los Angeles.

Filter House—Krebs Pigment & Color Corp., 2001 Benhill St., Curtis Bay, Baltimore, Md., manufacturers of titanium dioxide, copperas, etc., will build a 37x54 ft. filter house, a 3 story addition was completed recently and additional equipment will be installed.

Manufacturing Plant—The Gardner Gray-Card Sales Corp., R. R. Wise, Pres., Roanoke, Va., will build a plant for the manufacture of hair restorative and other products at Rocky Mount. $50,000.

Plant—Wisconsin Oxygen & Hydrogen Co., 6313 31st Ave., Kenosha, Wis., awarded contract for boiler room addition with equipment, to J. C. Tully, Kenosha. $28,000.

Copper Plant—Phelps Dodge Copper Products Corp., W. J. Kenealy, plant supt., South Front St., Bayway, N. J., awarded contract for copper processing plant on South Front St., to Wigton-Abbott Corp., 143 Liberty St., New York, N. Y. $500,000.

Glass Plant—Duplate Corp., subsidiary Pittsburgh Plate Glass Co., Pittsburgh, Pa., will construct with company's own forces 3 story, 15,000 sq.ft. plant annex to manufacture safety glass for automobiles at Creighton, Pa. $300,000.

Laboratory—William A. Webster Co., Memphis, Tenn., and New York, N. Y., awarded contract for constructing new laboratory building, to Memphis Construction Co., Memphis, Tenn. $20,000.

Physics — Washington University, G. R. Throop, Chancellor, Skinker and Forsythe Blvds., St. Louis, Mo., awarded contract for 2 story, tower and basement, 52 to 105 x 175 ft. physics building on north side of campus, to Dickie Constr. Co., 317 North 11th St., St. Louis, Mo. $250,000.

Lacquer Plant—United Lacquer Mfg. Corp., North Arlington, N. J., plans alterations and equipment of plant on Elizabeth Ave. and Stties St., Linden, N. J. Work by day labor and separate contracts. $28,000.

Factory—Fibre Board Products, Inc., Los Angeles, Calif., awarded contract for a 35x190 ft. factory addition on Pacific Blvd., to Lindgren-Swinerton, Inc., 523 West 6th St., Los Angeles, Calif. $10,000.

Paper Mill—Menasha Mill Supply Co., 615 Appleton St., Menasha, Wis., awarded contract for 2 story, 46x200 ft. paper mill factory, to Leon Le Roux, 164 West Foster St., Appleton.

Paper Factory — Bartram Paper Products Ltd., 1280 Homer St., Vancouver, B. C., have awarded contract for a 2 story, 66x165 ft. factory for manufacturing paper bags on Franklin St., to A. Sullivan, 4515 Connaught Dr., Vancouver. $35,000.

Rayon Mill—Tubize Chattillon Corp., Rome, Ga., awarded contract for constructing additional units to mill, to Fiske-Carter Corp., Rome, Ga. $400,000.

Factory—Kabro Oil Corp., 1765 Dahill Rd., Brooklyn, N. Y., will build by separate contracts a 2 story factory addition on Bushwick Ave. and Meserole St.

Refinery—The Canfield Oil Co., R. W. Helm, supt., Coraopolis, Pa., have awarded contract for continuous tube steel with a fractionating tower 5 ft. in diameter, 100 ft. high, secondary fractionating tower for further gas and naphtha refinement, equipment, storage tanks, pumps, receiving and control house, to Alco Products Co., 220 West 42nd St., New York, N. Y. $100,000.

Refinery—Gregg Texas Gasoline Co. c/o Clark Sample, Longview, Tex., plans construction 24,000 gal. daily capacity, casing head refinery. Work by day labor. $250,000.

Manufacturing Plant—National Silicates Ltd., 126 Bruce St., Brantford, Ont., awarded general contract for plant at Horner St. and Kipling Ave., to Wells & Gray, 17 Queen St. E., Toronto. $125,000.

Warehouses—Menomonee Sugar Co., Green Bay, Wis., awarded contract for constructing 2 warehouses, 60x250 ft. and 60x100 ft., at Oconomowoc, Wis., to J. C. Bosten, Green Bay, Wis.